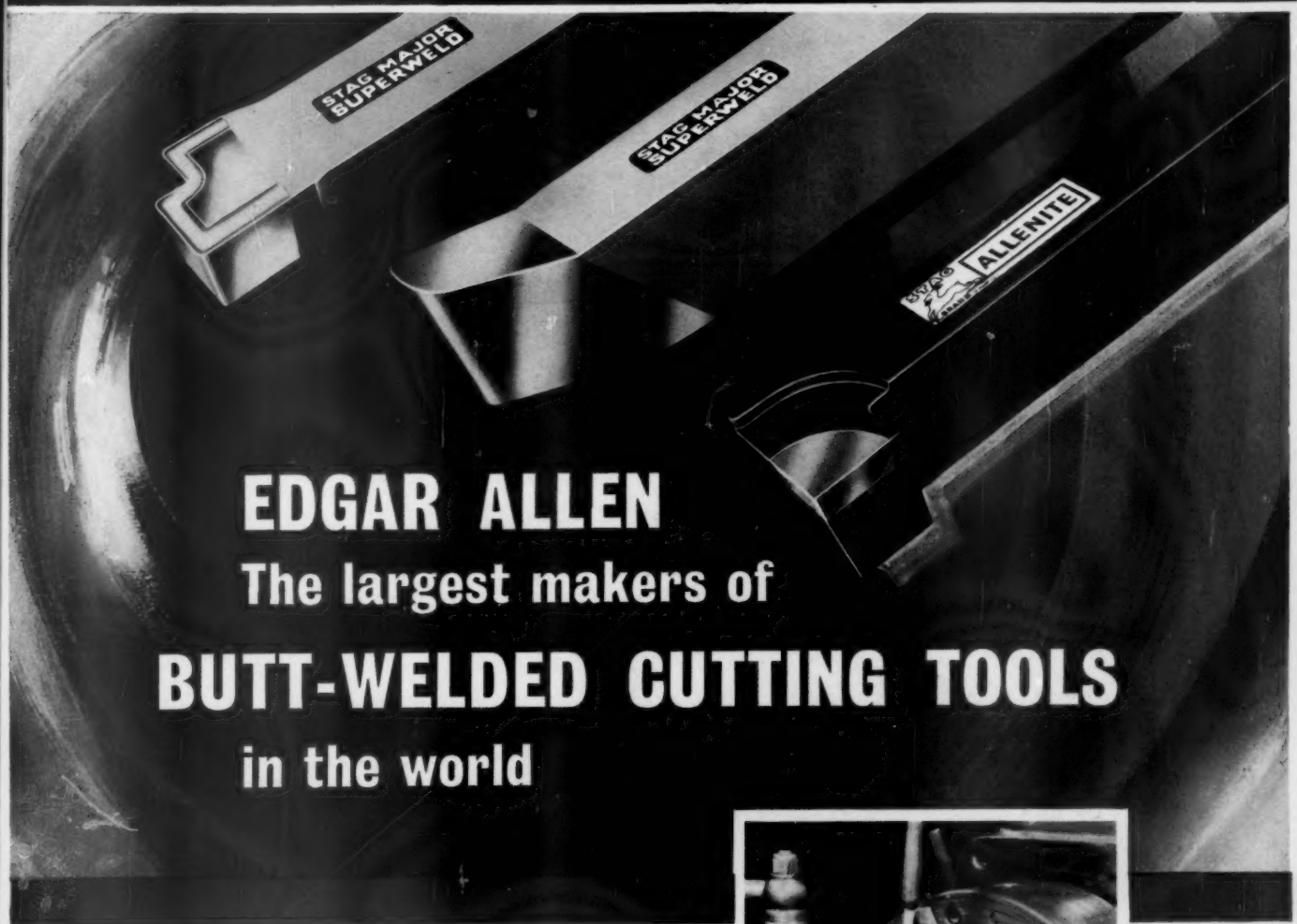

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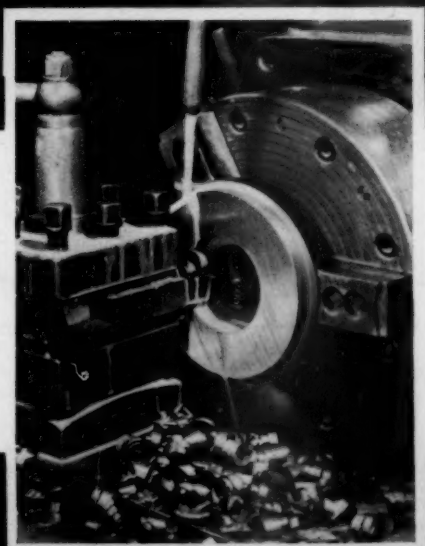

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Also angular misalignment.

Absorbs shock loads.

The trailing-link coupling

Compactly designed to accommodate substantial parallel and angular misalignment while transmitting power without loss of efficiency (less than 0·1%), Trailing-Link Couplings are available in a range of sizes for drives of 1—20 h.p. per 100 r.p.m.

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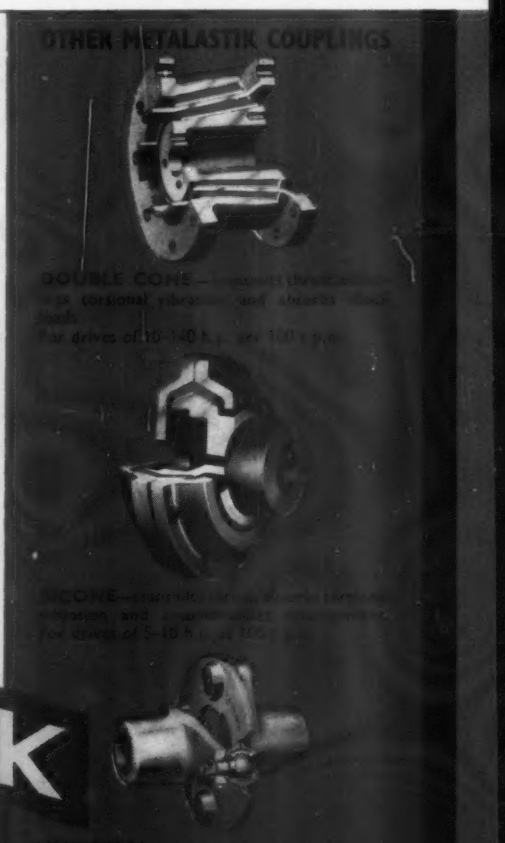

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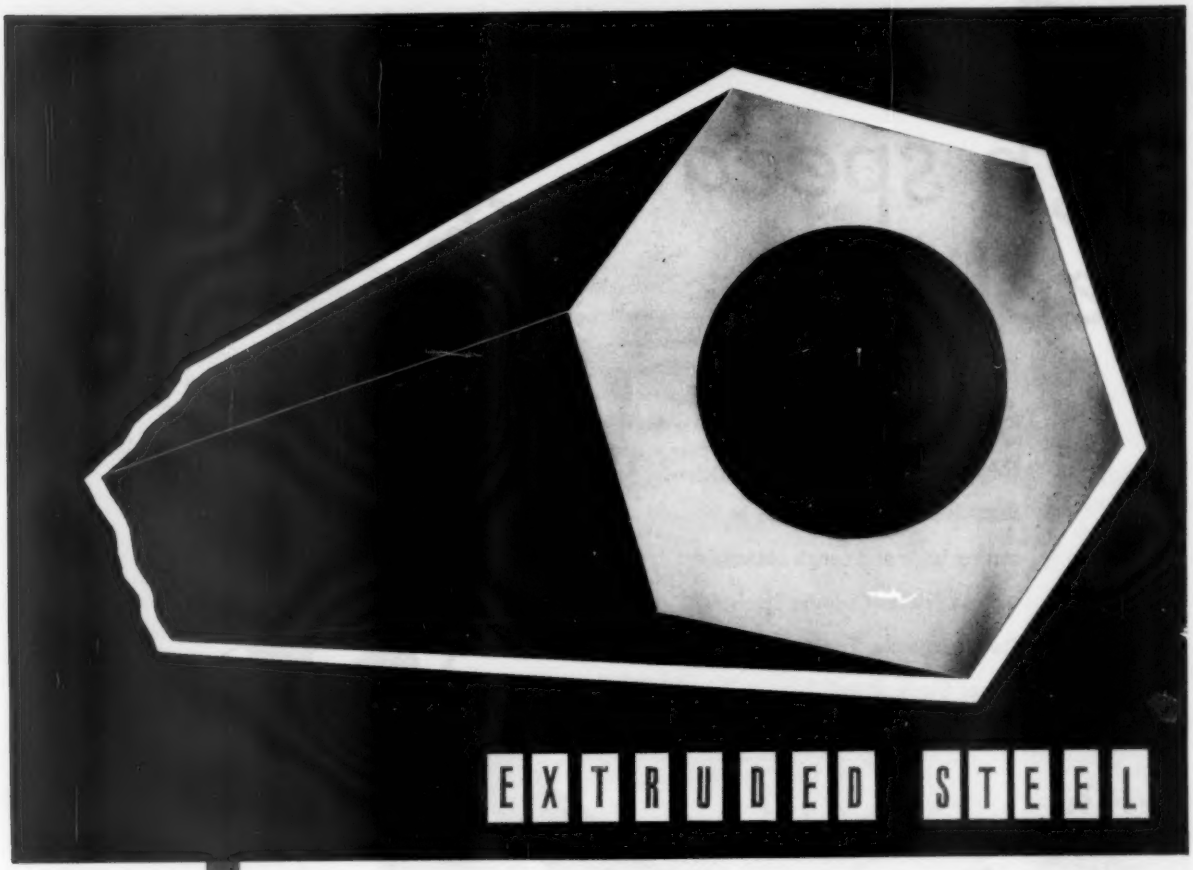
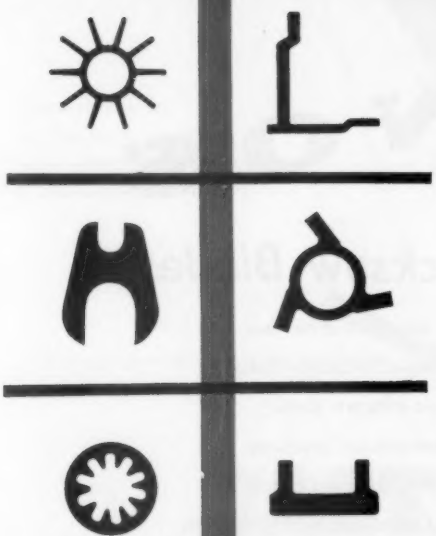


EXTRUDED STEEL

SECTIONS



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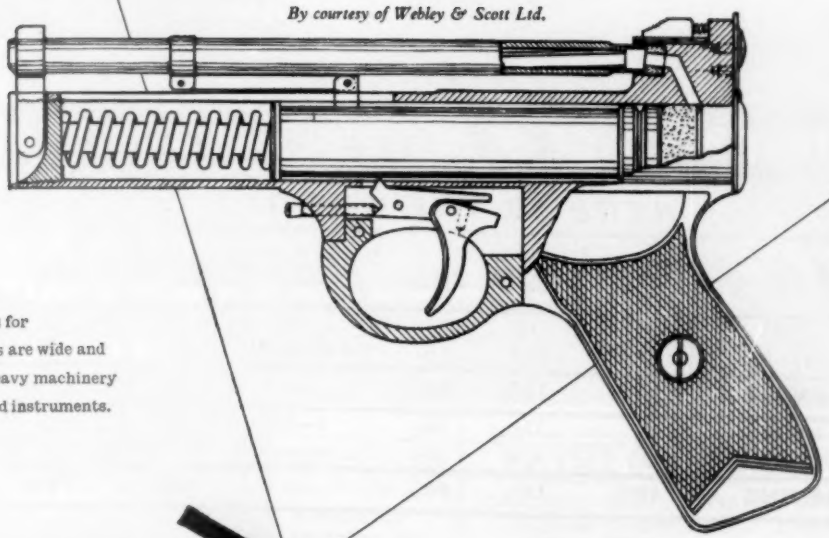

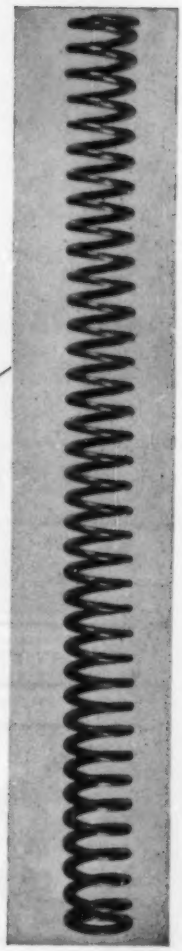

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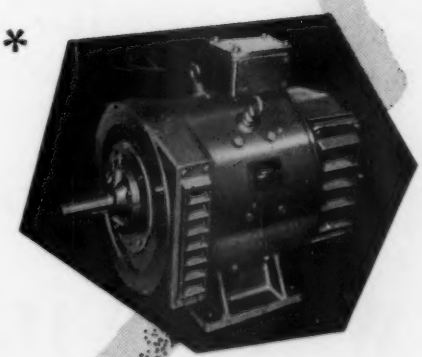

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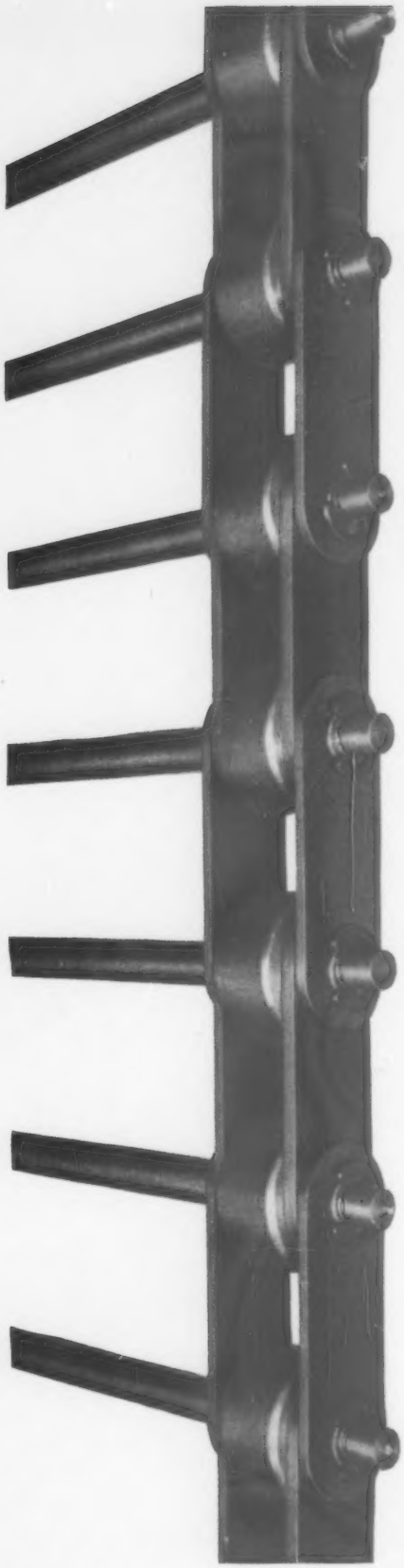

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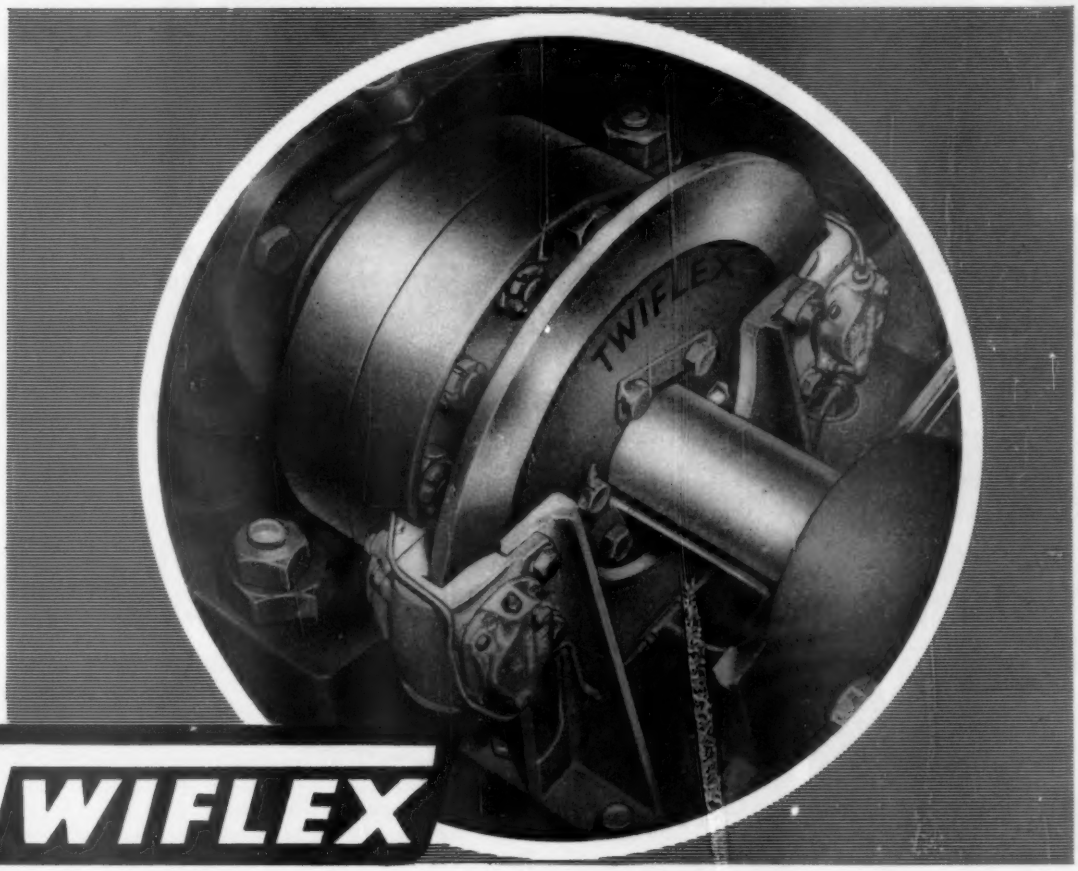

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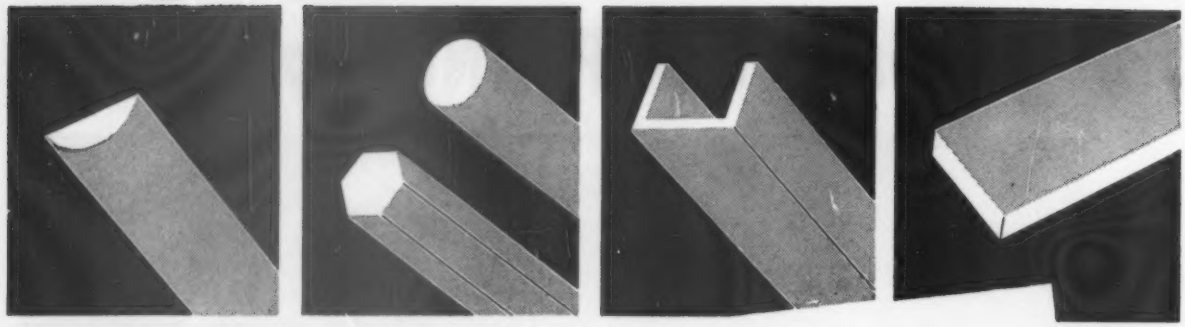

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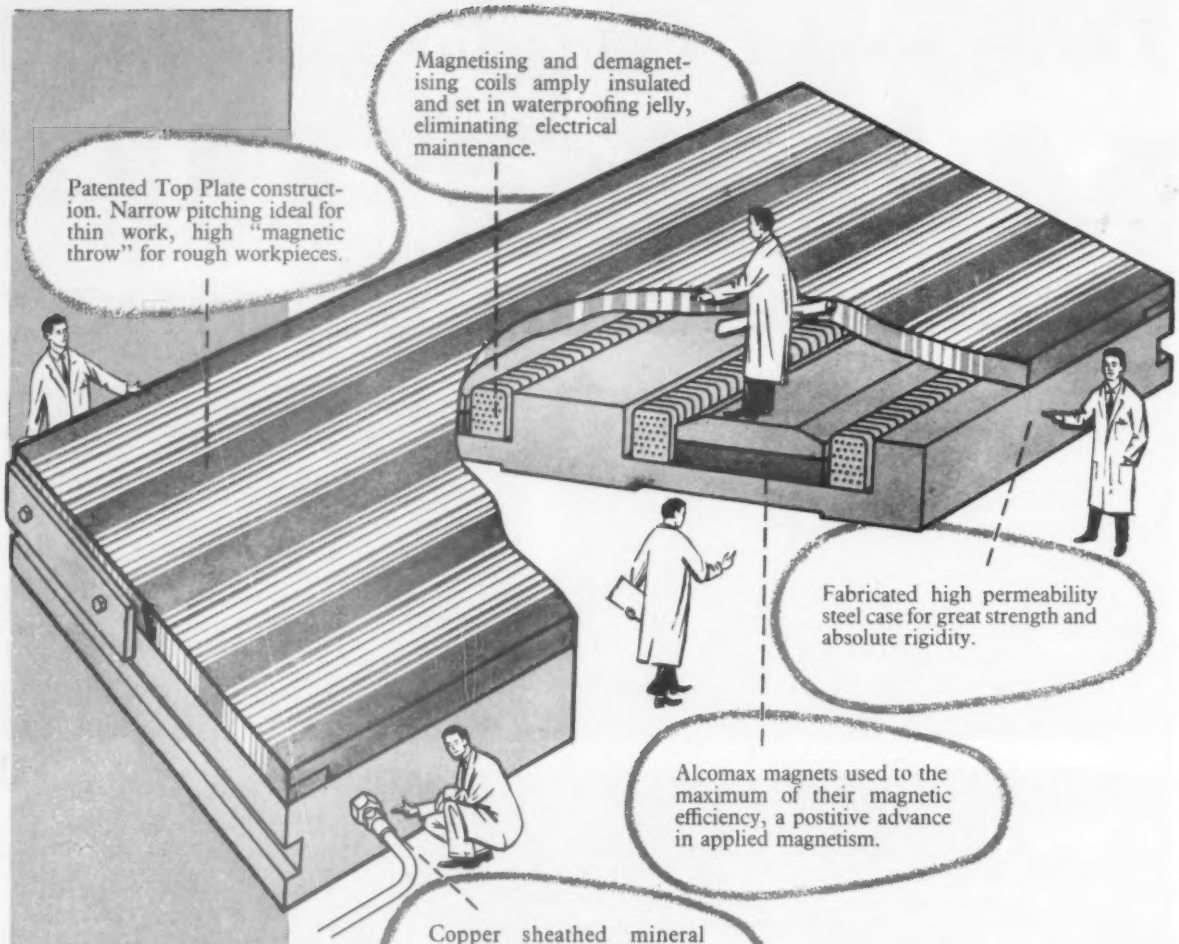
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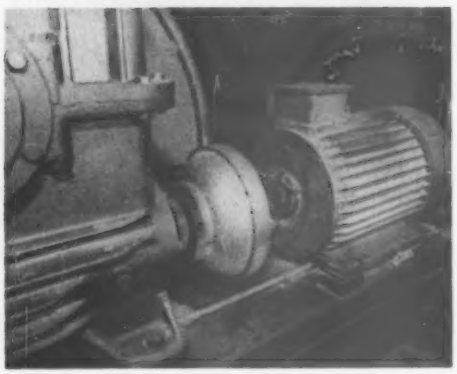

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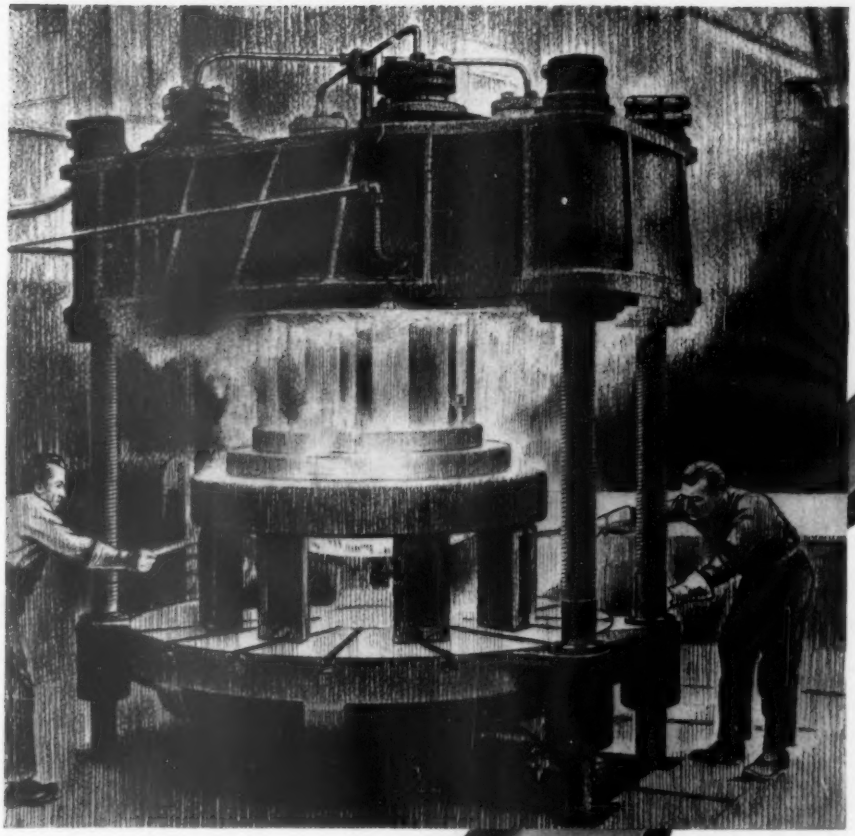

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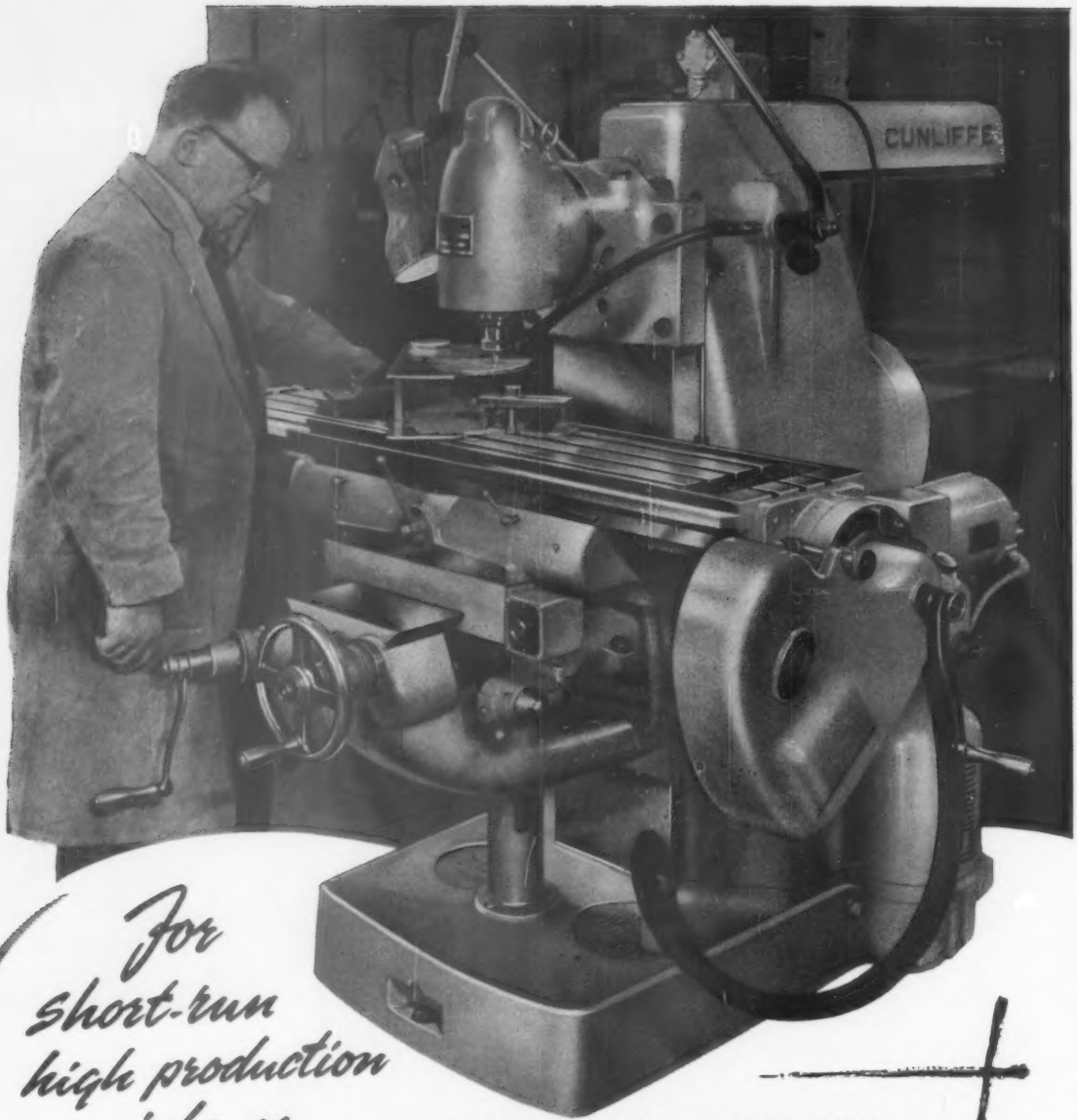

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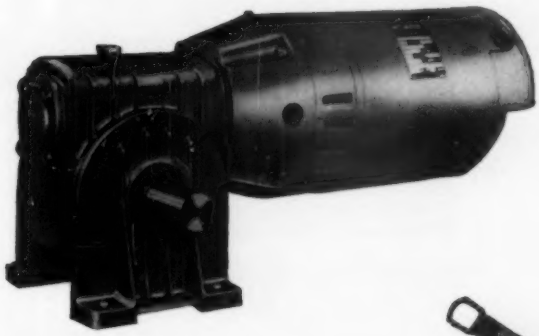

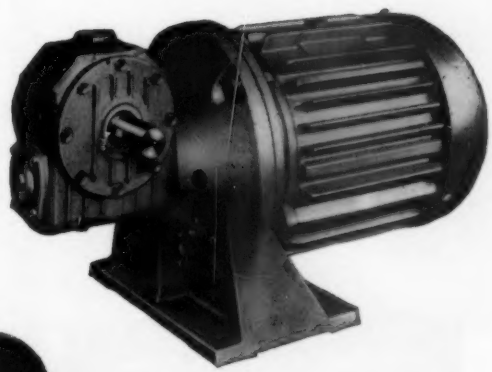

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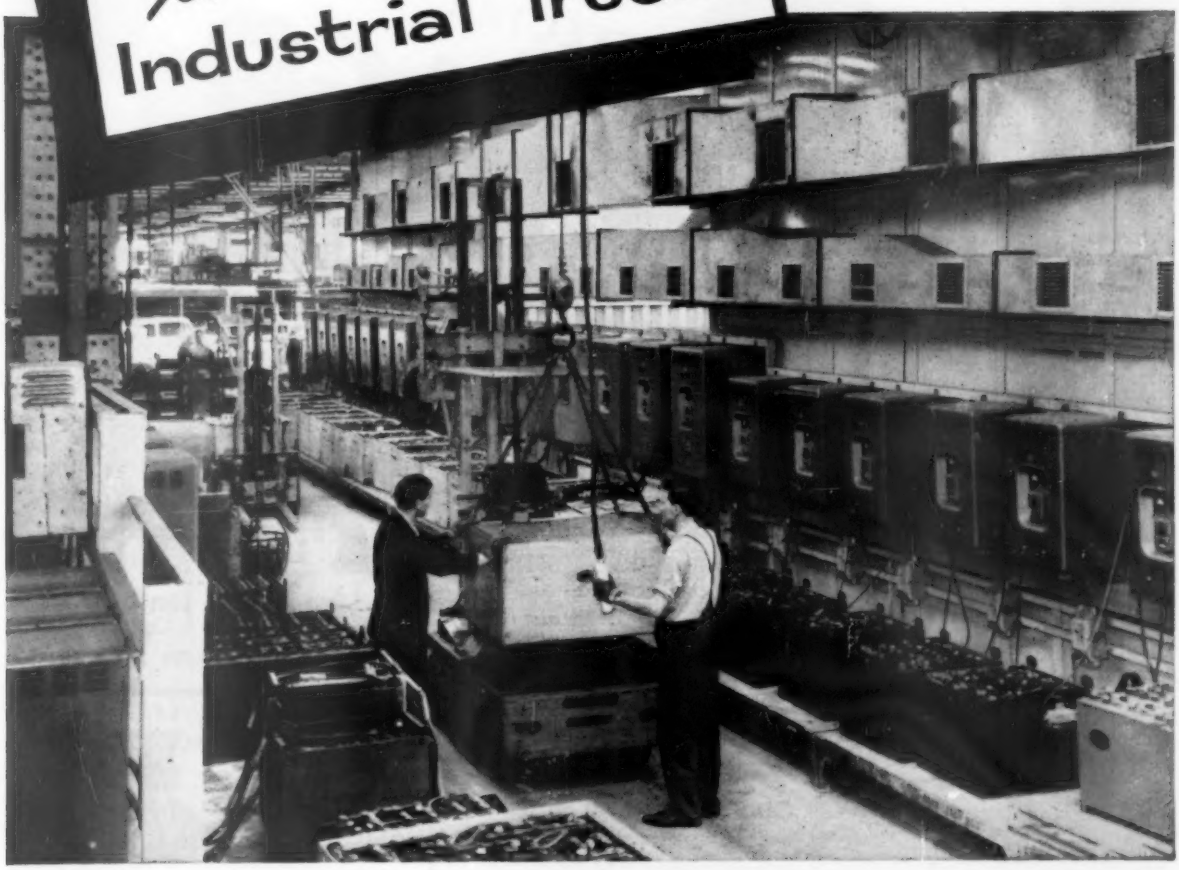

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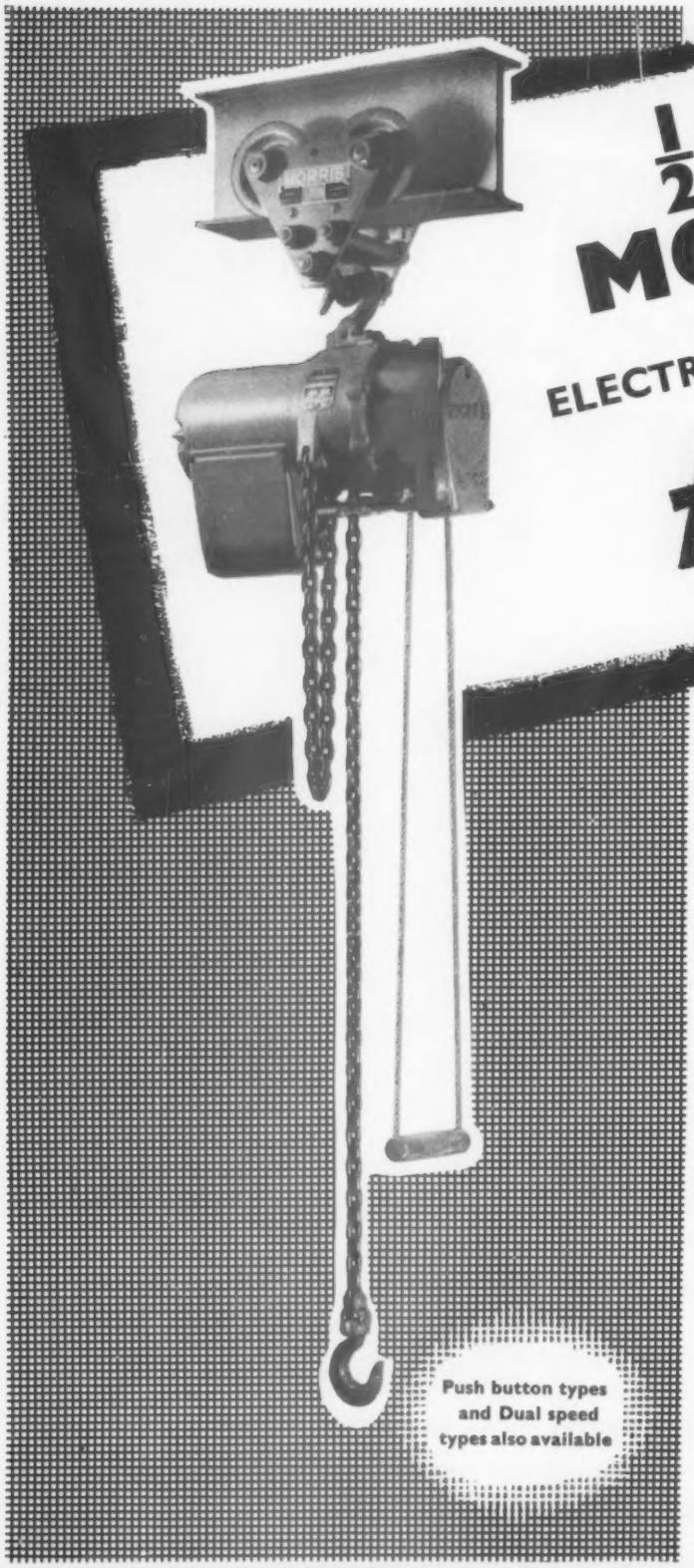

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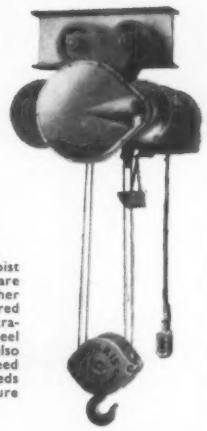

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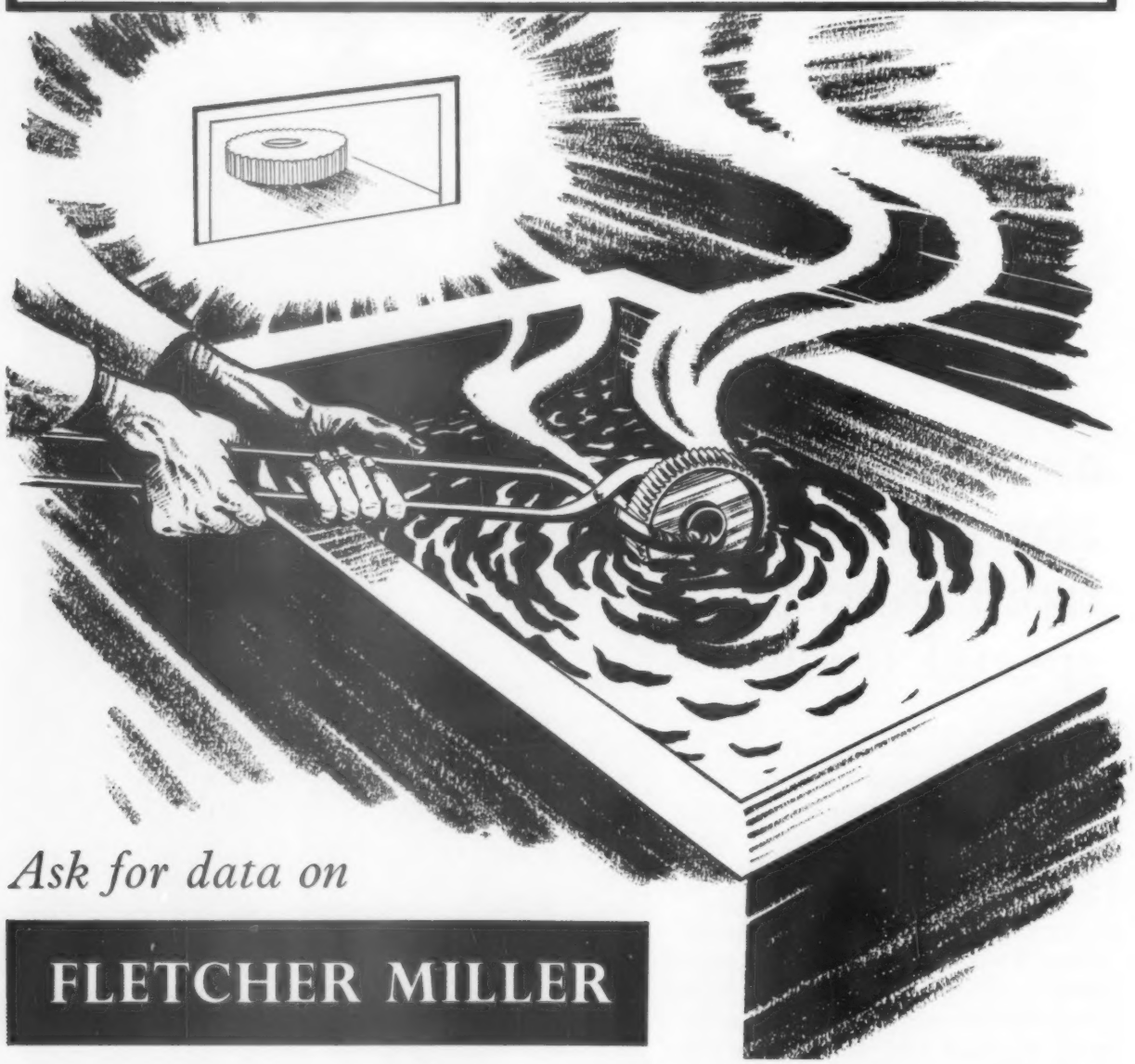

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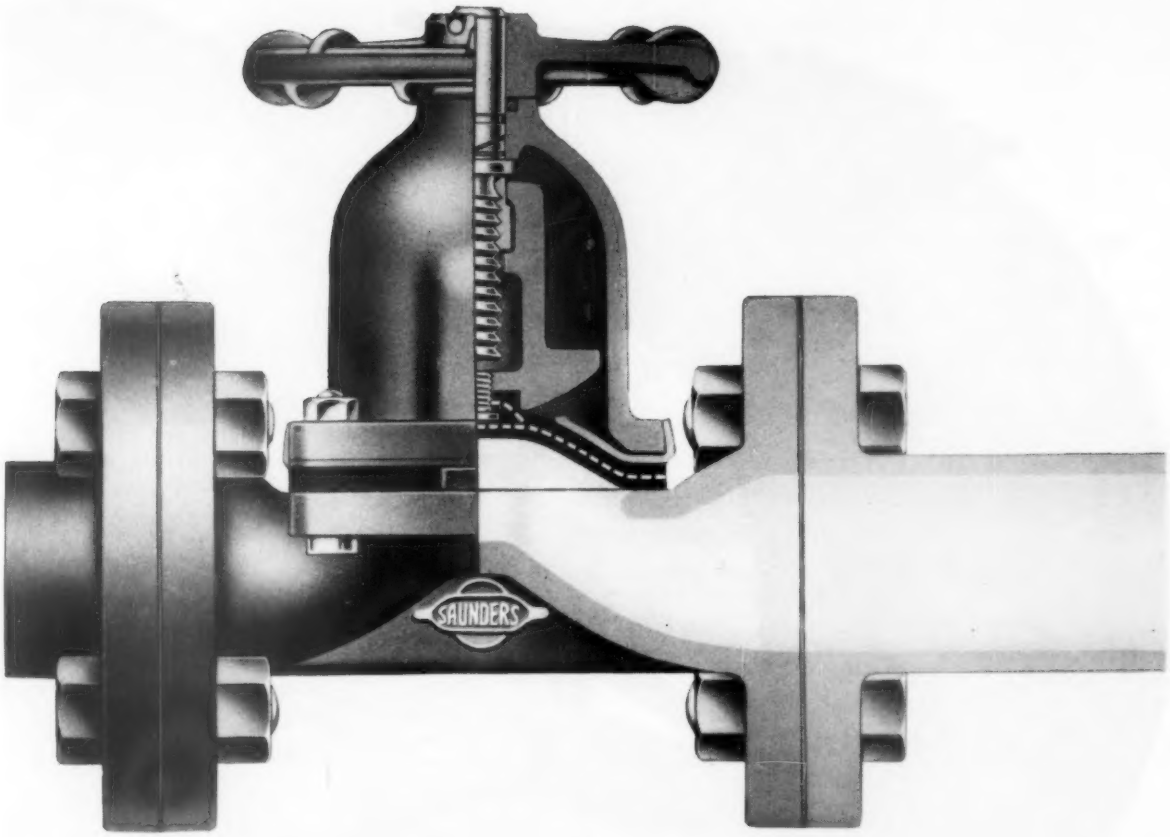

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Mechanical World

AND ENGINEERING RECORD

Vol. 140 DECEMBER, 1960 Number 3497

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Mechanical World —— December 1960

Machine Tool Reinforcement

THE British machine tool industry has experienced the economic effects of two world wars and their aftermaths; of overstimulation and painful recovery, of contraction and restrained expansion, and of unsuccessful as well as successful experiment with production methods. Looking at its products today and comparing them with those of preceding years there is evidence of continuous development and improvement, and the advanced present day designs are in the front line. Yet the industry is not happy: it has been criticized by Professor Melman in his report to the European Productivity Agency and it has criticized itself in its own report on Professor Melman's findings. It has a lot to say for itself too, and with just cause, but it knows where its own weaknesses lie—in research and professional man-power, and it knows how these can be put right. The remedy requires a specialized research association and a specialized school. These will not appear out of the blue, but since their value is so evidently appreciated they could, given the determination, be soon founded and put to work.

The machine tool industry is busier now than it was a while ago. It is encountering competition from the Continent which is imaginative and founded on research and plentiful professional skill. The Germans, for instance, are having success with their policy of being able to provide the customer with any kind of machine tool, whereas for the most part British makers concentrate on the standard machines for which they are noted. The Melman report has advocated mass production, module construction and greater standardization, all on the Russian model, for the European machine tool industries. Mass production is all right where the opportunity exists, as for relatively small machines for the developing communist countries. That is largely a closed market: however, there will be other opportunities, but they will be limited in extent and time. Established industry requires machine tools for replacement or expansion; tools to do more or cheapen the product, and usually (though not always carefully enough) the duty is particularly specified. Module construction is not now an innovation. In various degrees, depending upon the opportunity, it, or something very like it, has been with us a long time. And as for standardization, this is going on already and at an accelerating pace through the technical and productive achievements of specialist producers.

The British machine tool industry is relatively small, but it produces a considerable though not completely comprehensive variety and range of machines. In a few directions, in the use of electronics and computer control for instance, it is undoubtedly adventurous. For the bulk of the industry to move more quickly will require something more than the lagging effect of economic stimulus, nothing less, in fact, than what the industry itself advocates—reinforcement by more research and more appropriate educational facilities.

LOG SHEET

Automatic Letter Sorting

Post Office engineers have installed in the Luton Post Office prototype equipment to carry out the first experiment in automatic letter sorting. It comprises two machines known as letter coding machines, a large box containing electronic memory equipment, and an automatic letter sorting machine.

Letters posted in Luton, after being date-stamped, are fed into the coding machines at each of which an operator sits with a keyboard, like that of a typewriter, in front of him. The machine shows the letters to the operator, one at a time, in a viewing window. He reads the name of the town written on the letter and types on his keyboard the first three and last two letters of the name, e.g. if the letter is for Liverpool, he types the letters LIVOL. This action causes the coding equipment to print on the letter a pattern of spots, in a phosphorescent substance, representing the name LIVERPOOL. There is a different combination of spots for each of the 1,800 post towns in Great Britain. The letters then are fed into the automatic sorting machine which "reads" the spot patterns and sorts the letters automatically to the correct selection boxes.

The Post Office also plans to instal an automatic sorting machine at Mount Pleasant. This will take the letters from Luton which are routed via London for further sorting, and, reading the phosphorescent spot patterns on the envelopes, will sort them automatically to their destination. The Luton equipment will later be used to code and sort automatically letters incoming for delivery in Luton. If the combined experiments are a success, they will have proved that it is possible to replace all the manual sortings which take place during the journey of a letter by two simple "coding" operations—one to get the letter to the office of delivery, and one to direct it to the individual postman's delivery round.

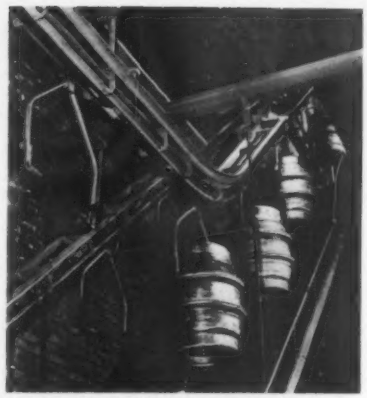
The maximum advantage would be gained if the two coding operations were combined into one and a complete pattern of spots—representing both the street and town address—stamped on the envelope at the office where the letter is first sorted. This could be done if the public would use a postal code at the end of their ordinary address which the machine would apply in the form of spots. Letters could then be sorted automatically at all stages.

Medium Wheeled Tractor

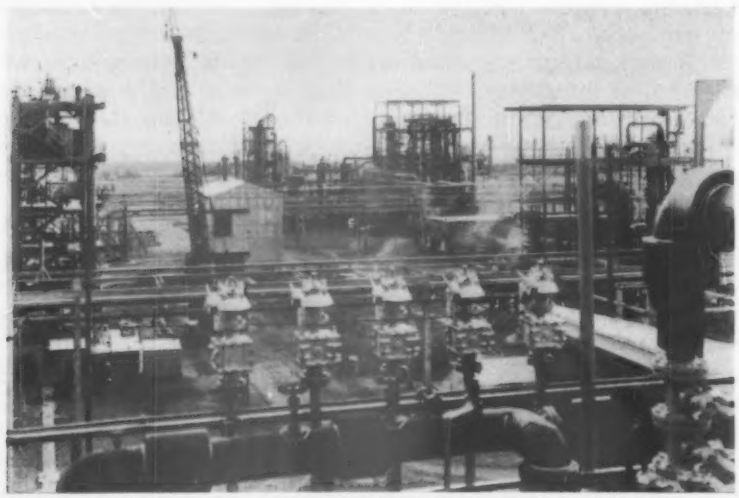
Changes in tactical concepts since the war have given rise to a military requirement for a highly mobile earthmoving machine for use in field units of the Royal Engineers. The new machine was required to take over the role of the light crawler tractor (Dozer) in forward units and, in addition to a high speed, should be capable of effective performance in dozing, shovel loading, and self loading an 8 cu yd scraper. In association with industry, the Military Engineering Experimental Establishment designed a tractor to meet this requirement. Prototypes were built, a rigorous testing programme was carried out and as a result, the War Office agreed, in 1957, that the machine should go into production. The contract was given to Marshall Sons and Company Limited, of Gainsborough and in June of this year the launching and handover ceremony took place.

Known as the Gainsborough, the new tractor can be fitted with an interchangeable bulldozer blade 9 ft 6 in. wide, or a 1½ cu yd (struck) loading shovel; a winch is fitted for heavy duty purposes and a cable control unit is provided for operating towed scrapers. The diesel engine is a Leyland 680 driving all wheels through a fluid flywheel and epicyclic gears, giving ten speeds in both forward and reverse directions. Power assisted steering works on all four wheels. The top speed is more than 30 mph.

The high reverse speed during bulldozing operations enables the tractor to achieve an earthmoving output in excess of the small crawler bulldozer which it is replacing. Under normal conditions it can self load an 8 cu yd (struck) towed scraper. The front shovel can be used for loading all types of earth and rock,



BARREL CONVEYOR.—In the Heineken Brewery in the Netherlands three different sizes of empty beer casks, 20, 35 and 50 litres, are conveyed from the cleaning machines on the top floor to the filling stations in the basement by a newly installed Teleflex dual-directional overhead chain type conveyor which handles casks at the rate of 300 per hr, but which is designed so that, with a minimum of modification, the capacity can be doubled. The casks travel at 20 ft per min and automatic loading and unloading devices have been designed by Teleflex using Martonair compressed air equipment



NEOPRENE PLANT.—Part of the newly completed Maydown Works of the Du Pont Company (United Kingdom) Limited, for the manufacture of neoprene synthetic rubber. The picture shows the monomer area, photographed from the top of the polymer building. The works are near Londonderry, Northern Ireland, and produce neoprene synthetic rubber and neoprene latex

as well as for excavating below ground level. On a test of loading 24 in. Basalt block stone into 5 cu yd tippers an output of 190 ton per hour was achieved. The hydraulically driven heavy duty winch with its 150 ft of steel wire rope and maximum line pull of 22,000 lb has instantaneous changeover from "pay out" to "take in" and overloading of the rope is prevented by the use of a simple hydraulic valve.

With the shovel fully loaded the tractor will manouvre on heather covered slopes of 1 in 4 and with an empty shovel, heather slopes of 1 in 2½ have been negotiated. Having a comparatively smooth underbelly, the tractor is able to continue moving through mud even when considerable wheel sinkage has taken place. On the road the tractor can maintain average speeds of 20 mph with safety. Fuel consumption on the road is approximately 6 mile per gal.

Shanks and Squares

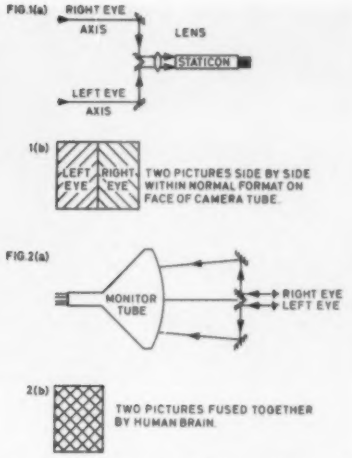
A great many sizes of square are used on parallel shank tools like taps and end mills. The International Standards Organization Committee 150/TC29 has recommended a reduction to 40 sizes with a mean ratio between the across flats dimension and the diameter of the shank of 0·8, and within a range of 0·75 and 0·85. This can be done by adopting values based on the R20 series of Preferred Numbers for the squares, and the intermediate values of the R40 series for the diameter ranges. At a conference of British manufacturers and users held on July 5 under the chairmanship of Sir Stanley Harley, chairman of the B.S.I. Mechanical Engineering Committee, the proposals were endorsed as providing a national series of squares and shank diameters which offers international interchangeability.

There is no compulsion on anyone to adopt the system, but it offers such advantages in international trading that it is sure to be generally used in time. It may be hindered at first by the current investment in jigs, tools and plant, but that will be countered by the economies to be made on replacement, by reason of the very great simplification offered by the system.

Stereoscopic TV

A new three-dimensional television system developed by Pye of Cambridge is particularly useful for remote observation, control and manipulation of materials and processes and can be attached to any existing closed-circuit TV installation. This is the first time in Britain that a 3-D television picture has been made possible when using only one chain of closed-circuit TV equipment. The equipment consists of a beam splitting attachment and a 14 in. mirror stereoscope. In order to appreciate how these are able to synthesise sense of depth in the mind of the observer, it is necessary briefly to explain the theory of stereoscopic vision.

Above, Pye industrial television camera with three-dimensional attachment. Right, Figs. 1 and 2, optics of stereoscopic systems



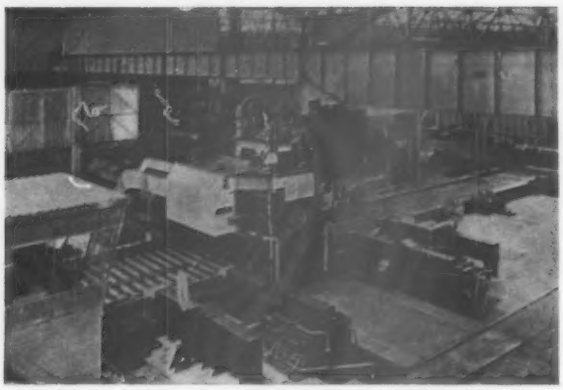
It is normal practice to use both eyes when observing one's surroundings, but since the two eyes see the scene from slightly different viewpoints the observer is really seeing two different pictures at the same time. The optical axes of the two eyes also converge to some extent to meet in the objects on which attention is concentrated at any instant. Mental processes then fuse the two different pictures into one which has the appearance of solid relief. This effect of relief and depth is the stereoscopic effect and this is lost in the normal television chain since the camera sees things from one angle only. To re-create the full sense of depth it is necessary to obtain two views at the same time with a camera having a means of obtaining those views from slightly displaced viewpoints, so that it copies the actions of the two eyes. The most obvious way to achieve this is by the use of two separate cameras which have their optical axes separated by approximately the distance between the human eyes; namely, 2½ in. However, if this system is adopted, virtually all the equipment required in a normal television chain will be duplicated.

In the Pye system the stereoscopic effect is obtained by a mirror beam splitting system at the camera position and a system of mirrors at the monitor position which have the effect of providing each eye with the relevant picture information as though the eyes were at the camera position. In order to understand the optics of these devices fully, reference is made to the diagrams above. In Fig. 1 (a) is shown diagrammatically the arrangement of mirrors used at the camera position and in Fig. 1 (b) is shown the right eye and left eye images which exist side by side on the face of the camera tube within the normal format. It will be appreciated that this is the picture that will be seen if this sign is applied to the normal monitor tube, but by using the mirror arrangement shown in Fig. 2 (a) it will be possible for the right eye to see only the picture produced from the right-hand viewpoint, and similarly with the left eye. The result, as shown in Fig. 2 (b), is a picture combined by the mind which will be stereoscopic. Furthermore, provided that certain other conditions are met, the picture will be orthostereoscopic, i.e. the effect on the observer's mind will be in all respects the same as if the observer were placed in the position occupied by the camera.

Aluminium Strip

Alcan Industries Limited, formerly Northern Aluminium Company Limited, is expanding its production facilities in a four-year programme which is expected to cost some £10,000,000. The intention is to increase output to meet the growing needs of established markets and also to provide the means of efficient production of commodities for which a demand has more recently emerged.

The scheme concentrates on improvements to the existing continuous strip mill which was laid down at the company's Rogerstone works in 1949 and 1950, when



A general view of the new 144-in. hot plate mill at Rogerstone

provision was made for an increase in output and range of product by subsequent development. It covers the installation of new equipment, the modernization of some existing equipment to increase operating speed and versatility, and at several points the relocation of plant to improve the flow in the mill. When the work is completed the nominal output of sheet and strip will be raised from 50,000 ton a year to 70,000 ton a year, plus a substantial extra capacity for hot-rolled coil and plate. A greater proportion of the output will be of material made from the stronger alloys, and also of aluminium alloy plate, which will be available in substantially greater widths than hitherto.

The plate, to a maximum width of well over 10 ft, will be rolled by the new 144-in. hot mill, which is the biggest item of new equipment being installed. This completes the facilities for the production of wide plate at Rogerstone, complementing a large stretcher, a plate saw and an ultrasonic inspection bath which have been operating since 1958. Aluminium plate can now be produced of sufficient size to satisfy the needs of the shipbuilding, chemical engineering and railway industries, who are showing a growing interest in aluminium, especially since the development of an efficient and commercially attractive method of welding plate and of alloys with good characteristics after welding.

The strip mill has now been brought to a point where further stages of development can readily be undertaken to the ultimate nominal capacity of 175,000 ton of plate, sheet, coil and strip in various alloys.

Lorry Cranes

The inaugural committee of the Lorry Mounted Crane Association, formed at the end of last year to administer and direct the activities of the newest industry in Britain, has now established the rules of membership. It sets out to guarantee a minimum standard of insurance, safety and reliability and will also endeavour to rationalize legislation regarding the use of lorry mounted cranes. Every lorry mounted crane, owned by a member must carry an inspection certificate which is to be renewed annually. Customers are invited to report inadequate registered machines to the association.

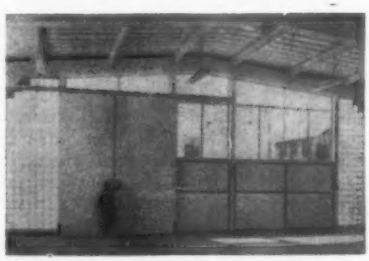
The association has defined a lorry mounted crane as a crane mounted on a vehicle with a minimum of six load carrying tyres and designed for road speed in excess of 15 mph. The crane must be capable of slewing through a minimum angle of 30° and its maximum safe working load must not be less than three ton. Other objects of the association, whose headquarters is at 301 Glossop Road, Sheffield 10, are to promote high standards in the practice of heavy lifting and to establish a minimum set of conditions of contract.

Wall Facing

Stelvetite, the plastic-coated sheet steel produced by John Summers and Sons Limited of Shotton, Chester, has been used to panel the inside walls of a recently completed single-storey building at Elm Works Limited, engineers of Summerstown, London SW 17. The building comprises 10,000 sq ft and was erected as a workshop to cope with an overflow from the sheet metal working and packing departments, and also to serve as a storage department and loading bay. It is constructed in pre-cast concrete with electrically heated floors and double glazing on the windows, the frames of which are in aluminium.

The inside wall facing, which is in white Stelvetite with a smooth glossy surface and trimmed with wooden beading, helps to achieve the maximum lighting effect and lends itself to easy maintenance. A 2 in. insulation material separates the Stelvetite from the brickwork. A large sliding door at one end of the building is also faced with Stelvetite. The outside wall of the building is clad with vitreous-enamelled panels, mauve in colour, and fabricated from John Summers' enamelling-grade steel sheet.

Stelvetite can easily be cleaned and is virtually unaffected by bumps and scratches. It has the strength of steel and is resistant to acids, alkalis, greases, humidity and abrasion. It has been found that the material can be bent, formed, deep drawn, joined and welded without damaging the coating.



Part of the Stelvetite plastic-coated sheet steel panelling on the inside walls of a recently completed single-storey building

Rail Centenary

The Gloucester Railway Carriage and Wagon Company, which this year celebrates its centenary, has enjoyed an eventful, creditable and, above all, successful history. A handsome and most readable centenary volume has been issued which narrates the important events in the company's story.

Founded in 1860 by a group of Gloucester business men the company's early years were extremely successful; in five years the capital had increased fivefold. Orders came from abroad as well as from Britain, and both India and Russia made use of the company's products. Business dealings with Russia raised problems in those days, too. Special grease had to be put in the axle boxes of rolling stock for the Russian railways, since, when they got the chance, the peasants ate it and the original grease was thought poisonous.

The second half of the century had its depressing periods but with the end of the Victorian age business generally improved. The company

now turned to road vehicles and ambulances were made for the Boer War, Lord Roberts using one of these as his mobile headquarters.

The First World War was a period of high profits consumed by heavy taxes and afterwards came the slump. But this was not taken sitting down; orders were sought after and won with a struggle. The 'thirties saw a notable improvement in business, under the chairmanship of Leslie Boyce. Then came the Second World War which inevitably brought about some dramatic changes. Altogether, 764 Churchill tanks were produced in addition to other military material.

Today the company has as its chairman a distinguished soldier of that war, General Sir William Morgan, former Supreme Allied Commander in the Mediterranean. The future for its traditional business of manufacturing carriages and wagons does not always seem easy but, if one can judge from its fine past record, the Gloucester Railway Carriage and Wagon Company will face it with confidence.

Clyde Tunnel

Work on the first of the "twin" tunnels under the Clyde is scheduled for completion at the end of next year. Work is then due to start on the second tunnel, finishing 1½ years later. When work started it was found that the ground in the approaches to the 800 yd tunnel was so porous that pumping water from the workings was out of the question.

To counter this it was decided to pressurize the tunnel to 50 psi. A large volume of air is forced up through the ground, keeping water out, and simultaneously providing ventilation. Any failure of the air pressure could mean a major disaster, with the workings collapsing and flooding within minutes. As a safeguard 13 electric motor driven compressors are in use, and two entirely independent mains electricity supplies are brought into the plant house.

On anti-vibration mountings in the Clyde Tunnel are these Blackstone diesel engines coupled with Electric Construction Company alternators, with Slatter switchgear. The sets are standby in the event of a mains failure

A further safeguard has been introduced; 270 kW generating sets are available as standby in the event of a mains failure. These comprise 6 cylinder turbo-charged radiator-cooled Blackstone diesel engines, coupled with Electric Construction Company alternators; with switch-gear by J. G. Statter. The sets are on anti-vibration mountings, and are started by compressed air.

A final safeguard is provided by a Blackstone mains failure set which can give emergency lighting to allow the workers to escape, and also act as an anti-panic agent while the diesel sets, which are on normal manual control, are started up.

Automatic Robotug

The driverless Robotug made by E.M.I. Electronics Limited, operates quite simply by following a wire through which a low-frequency alternating current is passed. Sensing coils on the front of the trolley detect any deviation from course and, like a bloodhound following a scent, stick rigidly to its path.

In an automatic system the track is divided into a number of sections or 'blocks'. As a Robotug proceeds its control unit energizes the section in front and de-energizes the section behind. In this way, there is always at least one dead section between two tractors. In systems using several Robotugs, this safeguard is essential to avoid collisions at junctions and crossings.

Robotugs are in use in Poland, Germany and Italy, and have been ordered for Canada. Others will be installed in several large British factories in the near future.

Each trolley has a control unit, into which an operator can program the necessary instructions, to make the trolley call at up to seventy-five different points for loading or unloading. Arrangements can be made to call at more points if desired. When restarted at the last of these, the trolley automatically returns to its original destination.

Experiments with these Robotugs —which combine the merits of a conveyor belt system and manually driven trucks at a fraction of the cost—have been going on at Newton Abbot railway goods shed for the past nine months. The results have been so encouraging that British Railways (Western Region) are planning further installations for some of their larger goods depots.

Marley Acoustic Pyramids in the factory of Smith's Motor Accessories, Watford

Acoustic Treatment

To reduce the noise caused by five braiding machines at the Watford factory of Smith's Motor Accessories the lower six feet of the walls behind the machines were lined with felted mineral wool slab, and three rows of Marley Acoustic Pyramids installed above it. A false ceiling was erected and covered entirely with pyramids. As a result there was a 49% reduction in apparent loudness.

A similar situation was encountered in the Constantine Line's M.V. *Thameswood* where the noise rendered by the engines made communication, even by shouting, impossible. Three-hundred Marley Acoustic Pyramids were installed—and measured results showed a four-fold reduction in the overall noise level, a decrease of six decibels. A further reduction of noise was obtained by dismantling the air intake trunking and fitting two specially made silencers, designed and manufactured by Marley's Acoustic Division, direct to the main engine blowers.

In the Research and Development Laboratories of Allen West & Co. Limited, Brighton, there was a need for an echo-less room where control gear could operate without undue noise, such as magnetic hum, and where high voltage discharges could be detected aurally and visually—often in complete darkness. This was achieved by lining a room completely —walls and ceiling—with Acoustic Pyramids. With these additions sound reflection was so minimized as not to impair the accuracy of sound level meter readings and aural investigations.

Testing Rubber and Plastic Hose

The aim of current research in the rubber industry is to devise ways and means for controlling production within closer tolerances. This review of the control techniques in use in a modern hose factory includes a description of a new electronic device for obtaining a continuous record of the internal diameter of small bore hose

By C. W. EVANS, Technical Manager, Hose Division, Dunlop Rubber Company Limited

THE phrase "testing rubber hose" conjures up filling a short section with air or water and seeing how much pressure it takes to burst, or perhaps a few spot size tests with a caliper gauge. However, to ensure consistent manufacture of a hose which meets modern standards, or perhaps exceeds them for some special application, a lot more is demanded.

Right at the beginning, all types of rubber, compounding ingredients and textiles must be rigidly controlled as they reach the factory, in terms of a specification agreed with the supplier. Further tests need to be applied while the rubber is being compounded and the hose manufactured. When manufacture is complete the finished product must be examined, care being taken that the tests applied bear a sensible relation to the service any particular hose has to give.

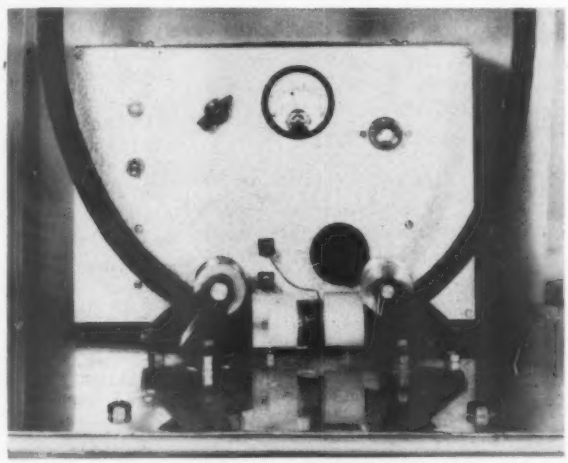
Nevertheless, this is not the end as far as the test organization is concerned. It is most important that test results are correctly interpreted. That is to say the significance of the figures must be known in relation to any margin of error, so as to avoid conclusions which are too optimistic, or taking a rash decision on a few unrelated figures which might result in a serious dislocation of production. This calls for a statistical approach to the problem, so that the final decision is soundly based.

Raw materials testing

At the beginning, we have tests on crude rubber, particularly in the case of natural rubber. The man-made product, being itself produced under closely controlled conditions in a chemical factory, can usually be relied upon to meet a specification within set tolerances. On the other hand, the natural product, coming as it does from different trees grown on different soils and subject to local variations, cannot be expected to have the same uniformity. Rubber growers have made great strides towards a more effective control of certain essential properties, such as speed of vulcanization and workability, but it is still desirable to blend incoming lots to mix up thoroughly deliveries from different estates.

Ingredients for compounding with the rubber usually come from the suppliers with a test report, but if not, tests are carried out in a factory control laboratory. This will be well equipped with both standardized and specialist instruments for chemical and physical tests. In the case of crude rubbers, tests are carried out for moisture and ash. In the case of compounding ingredients, the tests include microscopic ones on the size and shape of particles, moisture content, metallic impurities for certain ingredients and melting points for others.

Hose manufacture employs other important raw materials, such as galvanized round steel wire of 3–18 s.w.g., copper coated wire and liquor-finish high tensile steel wire of 30 s.w.g. and galvanized wire of various



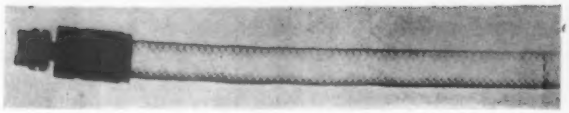
The prototype of a new electronic instrument for continuously recording very accurately the internal diameter of small bore hose. Where the hose passes through the coil it is loosely filled with ball bearings, which modify the character of a current flowing through the coil, according to the internal dimensions, so that a recording device can be operated

sections. A wide range of textile braiding is used, together with many miles of 4–20 oz per sq yd cotton belting duck. All these materials must satisfy specification requirements, in respect of such properties as tensile strength and elongation.

It is usually the case that no raw materials are released for manufacture until the control laboratory is entirely satisfied and has issued a certificate. With many large firms, this type of laboratory is approved by A.I.D. and other Ministry Departments.

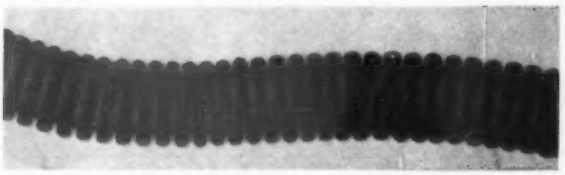
Manufacturing control

To ensure that a high percentage of output falls within the product specification, the manufacture of both rubber and plastic products needs to be carried out under close supervision. This is particularly important in the case of compound manufacture and is complicated by the fact that there are a very large number of different compounds to consider, perhaps not far short of a hundred in a large production unit. The compound and process instructions for making them are usually

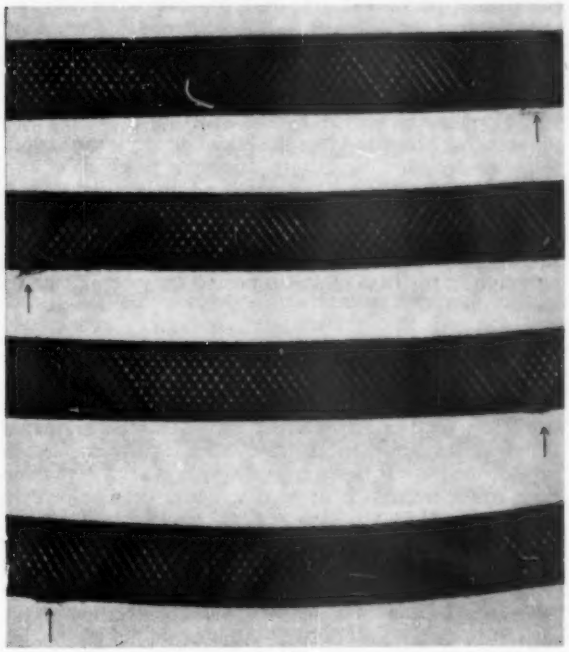


A

B



C



D

X-ray photographs are valuable in settling inspection queries, or as an instrument of research. Radiographs A, B, and C give a check on the regularity of construction of three types of metal reinforced hose. Radiograph D shows the displacement of the metal braiding that has taken place during a destruction test at excessive pressure

recorded on readily available cards and it is the function of a process control laboratory to see that these instructions are carried out.

To this end technical officers are attached to the production department, to watch for any sign of approaching difficulties. These officers see that samples of all compounds made are systematically passed back to the laboratory for tests on processability in the subsequent shaping operations, together with physical tests on the properties after vulcanization. As in the case of the separate materials, mixed rubber compounds will only be released for the next stage in manufacture, when the control laboratory has certified their quality.

Approved compounds next pass through the various processing operations, such as extrusion, calendering braiding, wrapping and vulcanization. These are supervised by patrolling inspectors, to ensure that the process is being correctly followed and to solve any production problem which might affect the quality of the final product. Special care is taken with continuous processes, such as extrusion and lead press vulcanization, to make a thorough check of the conditions at the start of a run, followed by periodical checks to ensure that no variations take place during the run. It is often the practice for each run to be metered by a production card, which is initialled at suitable stages by the officials concerned, to ensure that production continues according to specification.

Product testing

The culmination of all raw material and manufacturing control will be seen in the finished product and it is of primary importance that this shall be so tested as to leave no doubt that bulk production can be relied upon to meet specifications. There may be as many as a hundred different types of hose in production, more or less at the same time, ranging from $\frac{1}{8}$ to 27 in. bore and of widely differing designs. The tests applied vary considerably, according to the characteristics and service requirements of the hose; some indication of their wide range can be seen from the following examples.

A high pressure hose may have to withstand internal bursting pressures up to 25,000 psi; the lining of a welding hose must be resistant to various gases and many types of hose have to carry oils, fuels, coolants, steam, air or water at temperatures ranging from -40° C to $+160^\circ$ C. Sand blast hose must have a very high abrasion resistance and hose for edible liquids must have linings of rubber specially compounded to be non-toxic, tasteless and odourless. Certain types of hose need to have a white surface that is easily cleaned and others must be compounded to prevent the accumulation of charges of static electricity. Some of these properties are largely dependent on compound formulation, but with pressure and suction hose, reinforcement by application of metallic or textile braiding, wire helices and so on, is the operative factor.

With such a wide range of properties, the types of product testing called for are very diverse. In addition to straightforward tensile, elongation, ageing and abrasion tests on the basic rubber or plastic compound, the physical properties of the reinforcing material must also be checked. However, the most important tests are probably those which simulate service conditions on the finished product.

Where a hose has to carry a solvent material, its resistance to the swelling action of the solvent must be known within certain limits. Where the material handled is corrosive, resistance to the acid or alkali concerned must also be verified. Such properties are checked by examining the character of the hose after service conditions have been simulated, not only by examining the internal or external surface conditions and appearance, but also by dismembering the hose to check how service conditions have affected the bonding between

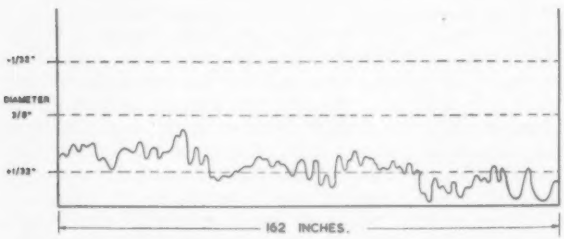
component parts. Valuable evidence about the relationship between the different metallic components in a hose can also be obtained by X-ray photographs.

In the case of hose designed to resist high pressures, bursting tests are of particular importance. These consist of proof testing hydraulically to at least twice the working pressure when the initial design is evaluated, followed by random testing during a production run to ensure that the initial properties are being maintained. Bursting pressures must be considerably higher than working pressures, to provide for the incidence of surges, the safety factor being normally four to one, although in the case of steam hose it may be as high as ten to one.

New developments in product testing

Existing methods of testing are always under review. This is to see how far it is possible to improve test efficiency, so that the product may either be evaluated within closer limits or the test more readily applied in production. A test development which is attractive from both considerations is at present under development in the Dunlop Hose Division at Gateshead.

With certain types of small bore hose, the internal diameter is often critical. While this can be checked from time to time by examining a section cut from the beginning or end of a run, it gives no evidence of the regularity of bore along the whole of the length, which for certain uses may need to be controlled within fairly close limits. A new electronic non-destructive test has recently been devised at the Dunlop Research Centre, which gives a continuous record of the internal bore of non-metallic hose within close limits, without the need to cut or deform the product.



Control chart showing internal diameter of a $\frac{3}{8}$ in. bore hose over a 162 in. length, obtained by the new Dunlop electronic instrument

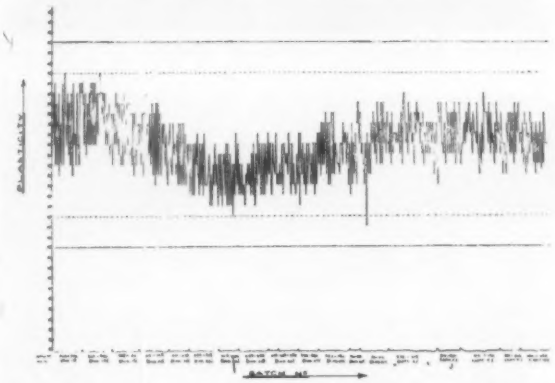
During production, the hose is caused to make a U-turn and at the bend of the U is filled with steel balls of diameter about two-thirds that of the hose bore, so that they roll freely without jamming. The hose passes through a coil of wire at this point and a high frequency current loading on the wire is continuously recorded. Any variation in the bore of the hose alters the volume of metal surrounded by the coil and its influence on the current passing can be readily detected.

Prototype apparatus is shown in the photograph and a typical chart obtained during evaluation tests shows how a tolerance of $\pm\frac{1}{32}$ in. on $\frac{3}{8}$ in. bore hose can be checked very accurately over the entire length of a production run. In practice, the apparatus is arranged so that light signals come into operation whenever the bore approaches maximum or minimum limits, so that corrective action can be taken in good time.

Because bore measurements are more critical with certain types of small bore hose, the new test has first been applied to this type of product: it is however equally applicable to non-metallic hose of any diameter. Other test developments now under evaluation, include a new form of hydraulic test which is more efficient than existing test procedures, together with other ideas stemming from current research and development.

Assessment of test results

However accurate the tests on raw materials, factory processing or finished product, they are of little value unless correctly interpreted. With each test the probable margin of error must be known. This tells the control



A routine chart from the control laboratories at Gateshead, showing the plasticity of lining compounds in relation to specification limits

staff just how significant is the information they get from instrument readings and enables them to take the right decision about future action.

The statistical method is extensively used at Gateshead and gives valuable results. The number of tests carried out with regard to any one property is determined partly by the accuracy of the test and partly by the significance of the test in relation to the performance of the hose. It is important that all control tests have a real meaning in reference to the process they are controlling. That is to say, no property should be controlled more closely than is required by service conditions, but when these have determined the limits, the control system should ensure a long trouble-free run well within these limits.

It is therefore valuable to express test results in chart form and keep the charts under continuous review. An efficient control system, with up-to-the-minute results displayed in graphical form, will do a lot more than indicate that a certain batch of hose is outside specification and has to be scrapped. If the results are correctly interpreted in regard to the statistical significance and clearly expressed in chart form, they will give ample warning of "trends" in production conditions, so that corrective action can be taken long before the end product has begun to stray over the limit-lines.

Testing rubber and plastic hose over the entire range demands a logical system for testing raw materials, factory processing and the finished product. The testing equipment should be first-class, effectively installed in a good working situation and operated by an experienced staff who fully appreciate the significance of the work they are doing. If the results obtained are understood correctly and the appropriate action taken, effective testing and control leads to smoother production and inspires the entire organization with confidence that the end-product will fully meet service requirements.

Developments in Electrolytic Machining

Electrolytic machining has advanced well beyond the laboratory stage and is now increasingly applied commercially in place of conventional machining and grinding on the harder or critical materials. Cavity machining by electrolytic processing has recently come into prominence, offering high stock removal rates. This article discusses the main current applications which are available, and used, on a commercial basis

THE removal of metal stock by "electrolytic machining" has advanced within less than a decade from a laboratory experiment to become an established production technique, yet the first commercial machines of this type (outside Russia) were only produced some five years ago. Of Russian techniques—that country being the first to exploit electrolytic machining to any degree—the picture is still far from complete. As far as the Western world is concerned, however, some five distinct types of application have appeared, all of which are usable on a commercial basis either as alternatives to conventional techniques or as first choice methods where conventional machining is not entirely suitable, or even inapplicable.

Electrolytic machining implies, basically, wet processing and in this respect is distinct from electric spark machining and similar discharge techniques, although the two are sometimes confused. They are essentially quite different methods of stock removal. The one is electrochemical by nature and the other electro-mechanical.

These two modern machining methods—electrolytic and electro-spark—have a common ground of application with the recent development of electrolytic cavity-sinking processes, with advantages and disadvantages on both sides. The electrolytic method is considerably faster for cavity sinking, stock removal figures of up to 18 cu in. per hr being quoted for commercial equipment, which compares with the 0·6 to 0·9 cu in. per hr stock removal typical of comparable electro-spark equipment. The operating process is more automatic and requires little or no mechanical control and—one of the most significant features of all types of electrolytic machining—no heat is generated by stock removal. On cavity machining, however, electro-spark methods have the advantage that the electrodes required are much simpler to make and less costly and that no question of corrosion arises as could be present with an active electrolyte. It is usually necessary, in fact, to fabricate the electrolytic fluid circuit in stainless steel because of this corrosion problem. Thus the electrolytic process inherently represents a higher initial charge which is unlikely to be justified, compared directly with electro-spark techniques, if a short run only is required from the electrodes. On a mass production basis, however, the considerably faster rate of stock removal may more than warrant its adoption.

Competitive with conventional machining, probably the most attractive field of application of the electrolytic process is in grinding, although this term is used in a sense of convenience only. Whereas there is a clear distinction in conventional machining between cutting with tools and grinding, electrolytic machining is simply controlled stock removal which may replace conventional cutting or grinding, or both.

Thus where a material is too tough to be cut on a commercial basis with conventional tooling because tool life is limited, electrolytic machining may well provide the answer. Similarly materials which do not take kindly to conventional grinding, because the heat generated may adversely affect their properties, can be worked cold by electrolytic methods. There are usually further advantages here: because no heat is generated the rate of stock removal can be speeded up, and because of the lack of physical contact the wheel life is extended so that redressing may not be required at all, or at least only after long periods of use.

Compared with conventional machining, apart from the advantages already mentioned, further savings can result from the fact that electrolytic shaping virtually ensures a complete absence of burrs. Thus a further operation—which may be essential with conventional machining—is eliminated. This characteristic of electrolytic machining has been found particularly advantageous in the production of honeycomb cores in such materials as stainless steel, etc., and for other critical components where no reliable method of deburring after machining is available. Currently, in fact, electrolytic machining of the less tractable materials and for critical components is one of the main applications of the process and far more established than cavity sinking which has only recently emerged from the experimental stage.

If these two applications described can be considered as electrolytic equivalents of machine work employing cutting tools, the other classes of application of electrolytic processing can be considered the equivalents of machine grinding. Because the application techniques are considerably different these are usually distinguished as single-point grinding, carbide-tipped cutter grinding and high-speed steel tool grinding.

Single point carbide tool grinding was one of the earliest applications of electrolytic machining and is now in widespread use. Attempts to develop the technique for sharpening carbide-tipped milling cutters and similar tools have, however, not so far resolved as a complete success. Stock removal is no problem for that can be obtained readily. The real trouble is that the wet treatment is messy, calling virtually for complete enclosure of the unit to avoid copious distribution of coolant or electrolyte over wide and far.

The other development of single-point grinding to the sharpening of high-speed steel tools has been more straightforward. The main difference involved is that the high-speed steel tool is invariably larger than the single-point carbide-tipped cutting tool and for a satisfactory rate of stock removal the current has to be increased. Otherwise the technique remains the same, limited mainly by the higher cost compared with conventional regrinding, although there is complete freedom from softening or burning as can, and does, occur with normal grinding.

Photoelasticity as a Design Tool

Photoelasticity, or "pictorial" stress analysis, is an invaluable aid to the designer, particularly for components which do not lend themselves to complete theoretical treatment. Three-dimensional stress patterns may be "frozen" in a prototype model, followed by sectioning for detailed analysis

IT is an axiom of boat designing that "seeing the spray" is an invaluable guide to the hydrodynamic performance and efficiency of the hull—if, unfortunately, a little too late at this stage to undertake any major design changes which may appear called for. A similar state of affairs commonly arises in engineering design where stress analysis is essentially theoretical, and stress concentrations or other faults not allowed for in design will ultimately show up as failures. Photoelasticity is a method of "seeing the spray"—or stress distribution in this case—at a preliminary or mock-up design stage, thus providing empirical data in the form of a visual picture of the stress pattern for subsequent interpretation and analysis on conventional lines. In many cases, in fact, it is the only practical method of determining stress distribution in a particular design and although the application is necessarily deductive, it is far more accurate than the "guesstimation" which is all too frequently used. The normal factor of safety allowance is, after all, basically a factor of ignorance.

Photoelasticity as a technique is not new. It was first employed at the beginning of the present century in elementary form and from this has developed slowly into an established method, not only for pure research but also as an aid to production design. It is used both to check theoretical calculations as well as to evaluate otherwise indeterminate stress patterns. Basically it is a simpler and less expensive method than mechanical testing, although it cannot replace the necessity for the latter as a final proof in critical designs. Its scope of application is, perhaps, still somewhat limited, but this is a condition which will undoubtedly improve. But where applicable it is considerably more informative than the other simple pictorial stress analysis techniques, such as brittle lacquer coatings, which are essentially limited to evaluating surface stresses.

The basis of photoelastic analysis is that a model of the design or prototype under investigation is made in a suitable optical plastic material. This model is then loaded in such a way that the external forces applied exactly duplicate those anticipated on the actual design part in service. The resulting internal stresses produce a lack of homogeneity in the optical plastic which, when viewed under polarized light, show up as interference patterns following the distribution of internal stresses. In other words, the interference patterns provide a plot of stress distribution from which both the directions and magnitudes of the stresses can be deduced.

It is then logical to assume that an exactly similar stress distribution will be produced in the final design, fabricated in its own material. This is only valid, however, if the mechanical properties of the model material are compatible with the production material in overall behaviour; and also if no parts of the stress pattern exceed the linear strain range of the final material. In the latter case the behaviour of the final material in this region may be considerably modified by the fact that it is working beyond the linear region of stress-strain, although it may be possible to estimate the stresses concerned.

Photoelasticity is applicable both to two-dimensional and three-dimensional analysis, the latter obviously having more scope and presenting a truer and more complete picture, although the problem itself may be basically a two-dimensional one. The former method may be applied to produce useful data more rapidly and where two-dimensional analysis is satisfactory, such as investigating the stress distribution around holes and cut-outs in flat panels, etc., one 'view' only of the interference patterns is then required. It must be appreciated, however, that two-dimensional analysis of a three-dimensional problem can be highly misleading.

In the case of three-dimensional photoelastic analysis the method now commonly favoured is that of 'stress freezing' where the loaded model is subjected to a controlled heating cycle which has the effect of fixing or 'freezing' the plastic in its stressed state. This renders the plastic completely stable in the stressed state so that it can be cut or sliced up, as required, without disturbing the stress pattern, and thus individual sections from any part of the whole examined. Neither the original 'freezing' nor the subsequent cutting provides any measure of stress relief to modify the original pattern induced by loading. Thus the 'freezing' technique is particularly useful where 'core' or central stresses have to be investigated, as well as providing a method of obtaining a complete three-dimensional picture of all the internal stresses by sectioning.

Various materials may be used for construction of the original model, an epoxy resin (Araldite B) being commonly preferred as possessing suitable optical and mechanical properties as well as rendering manufacture of the model easy. It is not necessary that the model be made full scale, although this is usually done, if practicable. Where other materials may be employed in association with the plastic consideration may have to be given to the difference in thermal expansion on heating (usually of the order of 120° C with Araldite B) as otherwise false stresses may be introduced and frozen into the final pattern. Otherwise the basic technique is simple, straightforward and logical. A pictorial record of the pattern enables the stress lines to be investigated in detail and stress magnitudes calculated on the conventional basis of the theory of elasticity.

Steel Yields More of Its Secrets

Each year that passes brings new discoveries regarding the properties and behaviour of steels under certain conditions, and some of the effects that can be produced are subtle and of practical importance. In the following notes an account is given of some of the interesting facts recently revealed as a result of intensive research

HOW does the removal of metal from the surface, and the regions close to the surface, of a hardened steel affect its performance; and how does heat treatment affect it? It is by no means easy to determine this, and moreover such effects as are produced are not fully controllable. A common defect associated with a heat-treated steel is the presence of soft skin, the decarburized zone on the surface of a heat-treated part. This is usually ground off, the operation removing a few thousandths of an inch.

But this grinding operation itself brings about a number of surface effects with the result that a fully hardened workpiece may lack uniformity in phase and in the distribution of stress close to the surface, and these nonuniformities may seriously influence the physical properties of the finished parts. Investigation has sought to determine a relation between heat treatment and final finishing operations and the performance of the product in terms of a number of physical surface properties, such as retained austenite and residual stress distributions.

It has been clearly shown as a result that the amount of retained austenite may vary considerably as a result of, for instance, mechanical metallographic polishing. It is claimed that belt sanding produces a rehardened surface layer containing 100% retained austenite, but critics have argued that this can be disputed. What is clear is that rough polishing affects the steel to a depth of several thousandths of an inch. When hardened steel is ground with extreme care, there may be only the slightest trace of tempering, and this will show up as a slight darkening after suitable etching.

Another interesting subject is the banding of steel, which is caused by carbon segregation into preferred regions. It is usually believed and accepted that the principal explanation is that alloy segregation affects the amount, kind and form of banding. A few of the factors involved include austenitizing temperature and time, diffusion rates of carbon and alloy, grain size, cooling rates, and rates of nucleation and growth of decomposition products of austenite. A great deal of the argument regarding banded structures owes its origin to the lack of knowledge regarding the effect of these different factors. To remedy this, investigations of considerable interest have been carried out.

These reveal that the main explanation of banding is, at all events in parts made from rolled steel, a lack of chemical uniformity. This develops perceptible banding because of its influence on nucleation and the growth of ferrite and pearlite from austenite. The pattern formed is governed principally by the total effect of alloy heterogeneity on carbon segregation. Carbide-forming types of elements increase the concentration of carbon in their region, while solution-type elements, of which nickel is an example, decrease carbon concentration in their neighbourhood. Consequently, in single alloyed steels, the amount of carbon segregation and the location of high and low carbon areas in relation to a fixed marker are governed by the quantity and distribution of the one alloying element, and by nothing else.

The metallurgist is by no means blind to the developments in research tools. Science has already made use of radioactive tracer techniques, and it was at once seen that these might be of value in research into metals. One of the problems with which users of steel have been faced of late years is the poor hot forgeability of steels, and it was thought possible that this might be caused by the addition of rare earth particles. As an aspect of this research, the evaluation of these particles was regarded as a potential cure.

One obvious effect has been an interest in microstructure, and any proof obtainable of deleterious influence of intermetallic compounds or non-metallic inclusions. To find out more about this, research workers have tried the effect of adding radioactive tracer elements with a view to discovering the location and distribution of impurities not disclosed by normal metallographic techniques.

The experimental technique developed is most promising because it may help to solve intricate problems both in the laboratory and in production. A stainless steel was chosen for the tests, and it was found that if a radio-active misch metal (a natural mixture of rare earth metals) was added, it was uniformly distributed throughout the matrix of a 25-20 nickel chromium steel melt. Some small concentrations of radioactivity were found in the interdendritic zone of a specimen in the as-slow-cooled state. Moreover, the forged specimens indicated a degree of variation in concentration between the outer and centre sections of the specimen.

During World War II there was a surprising and disconcerting series of failures of welded merchant ships and tankers. When these ships were examined it was discovered that they displayed an extremely large number of running brittle cracks, which occasionally had distressing results. It was speedily appreciated that this problem involved the toughness of the steel in the presence of stress-raisers such as notches. By improving the design, cracking was notably reduced. Another modification of design to be highly effective was the breaking of the continuity of the all-welded hulls of the welded ships by riveting a number of rows of plates to act as crack arresters.

Nevertheless, even with perfect welds and good design, notches may still be present to concentrate stress. These may be caused by handling when the ship is being built, by tack welds, by repair work, and by slight indentations and shocks during service. It is essential, therefore, that such ships should be constructed of steels tough even when notches are present. Investigation of the problem showed that in such large structures it is necessary to employ plates having a transition temperature sufficiently low to provide notch-ductility. The ability of plates to arrest cracks may be regulated to a considerable degree by composition and methods of production. Correlation

of test results with failures in service has determined the value of tests and shown the compositions and steel-manufacturing practices that can give satisfactory performance in the different ranges of thickness, Research has also led to the use of higher ratios of manganese to carbon than were originally employed in semi-killed ship plate.

Metallurgy at low temperatures is another important subject of research. At such temperatures long-range diffusion is impossible, but changes may occur, nevertheless, as a result of atoms jumping into adjacent positions and travelling only short distances. Phase changes then occur with no alteration in composition. The mechanical and physical properties of metals and alloys in this range of temperature demand a knowledge of crystal imperfections. Defects may be caused by cold working, martensitic transformations, bombardment with particles of high energy, or by quenching-in the defects in thermal equilibrium at higher temperatures.

For many investigations, researchers have related specific defects at these low temperatures to certain properties of metals. No one set of defects is the cause of the low temperature brittleness of metals because this is related to the presence of anchoring atmospheres, dislocation arrays producing concentrations of stress, and possibly to micro-cracks, all these being factors that increase local stresses on cleavage planes.

The quench-ageing of low carbon steel is marked by noticeable changes in physical properties. It is now considered that these are the product of decreasing solubilities of carbon and nitrogen in ferrite with decreasing temperature. During recent years the reactions occurring during quench-ageing had been investigated using a number of techniques, but more information was necessary regarding the morphology and lattice structure of the precipitations formed on quench-ageing. To obtain this, these changes in a number of alloys have been followed with the aid of light and electron microscopy. Electron diffraction was used to identify the precipitated phases.

As a result, there is now internal friction evidence favouring a two-stage reaction during the ageing of ferrite supersaturated with carbon.

The widely useful mechanical properties of special and tonnage steels are fundamentally governed by the structures developed under conditions of commercial cooling, and this applies even after additional tempering, annealing, or work at high temperatures. In consequence, the solid-state reactions taking place when austenite decomposes ought to receive greater attention than transformations in any other alloys of a single base metal. To establish the proper heat treatment of five nickel-molybdenum, chromium-molybdenum-vanadium and nickel-chromium-molybdenum deep-hardening steels, both isothermal and cooling transformation curves have been determined. Hundreds of specimens collected under such controlled conditions have also been studied under the optical and electron microscope to show up the structural details needed for mechanistic interpretations.

These show an upper 'knee' for proeutectoid ferrite, a region of extremely slow reaction, and a lower 'knee' for bainite. Other technical conclusions have been drawn.

The carburizing of steel parts is a process of long standing. It is increasingly recognized, moreover, that one effect of developing a hardened case in a steel part by a carburizing treatment is the production of residual stresses of compressive type, usually located in the hardened surface layers. These are entirely beneficial in applications involving fatigue, and the advantage gained is governed by the precise magnitude and depth distribution of the stress. It has therefore been considered useful to establish the distribution of stress in carburized cases by means of X-ray diffraction. A widely held theory is that these residual stresses arise because the hardened case is in compression as a result of its greater tendency to expand during the hardening transformation, and the resistance of the core to this expansion.

The investigation produced evidence to support an alternative theory attributing the development of the residual compressive stresses in the hardened case to the sequence of the transformations of the austenite to the different products forming in various parts of the case and core. In this theory, the introduction of carbon into the surface layers lowers the martensite starting temperature (M_s) of the case, so retarding the transformation of the austenite of the case to a lower temperature and correspondingly later time than the transformation of austenite in the core.

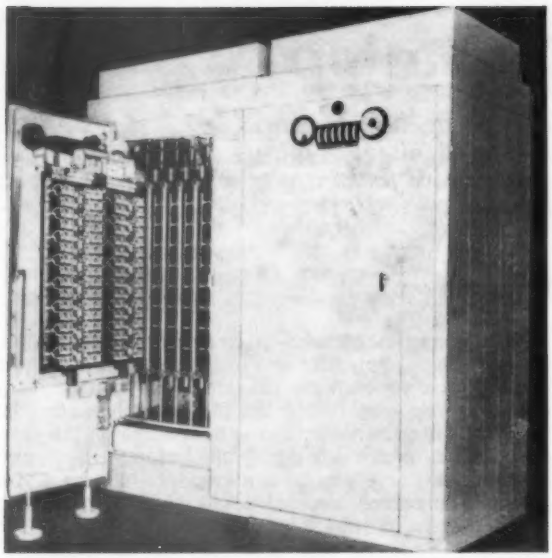
The techniques adopted not only help to evaluate residual stresses and indicate their origin, but also to evaluate the quality of carburized cases. They also provide a quantitative measure of the effects of decarburization or the effects of carbides at the surface of the case, when present.

The changes in the saturation intensity of magnetization and in the cementite Curie point of a steel, occurring by reason of plastic deformation, are specially interesting because they are usually considered to be governed solely by chemical composition and grain structure. An investigation was carried out some time ago to examine the effects of cold work on cementite in steel. Thermomagnetic analysis supplemented by X-ray observations were used. The experimental results obtained and the large number of theories developed to account for them are most interesting, but show a need for further investigation of this highly intricate matter. Broadly, it was shown that when a plain carbon steel is cold-worked, the carbide Curie point inflexion is apparently displayed and extended, while there is an increase in the saturation intensity of the magnetization. The apparent carbide Curie temperature of such a steel increases smoothly and gradually as the amount of cold work increases, while if the steel is reheated after cold-working, this Curie temperature recovers in the same way.

Silicone Grease

A new silicone grease, M.494, has been added to the range of silicone products from Imperial Chemical Industries, Imperial Chemical House, Millbank, London SW1. The electrical qualities of M.494, coupled with the silicone characteristic of water-repellency, make it particularly suitable as a sealing agent for electrical equipment, and as a general agent to protect surfaces against moisture.

The many specialized and varied applications of the new product include: protection of insulations from corona discharge; sealing and potting grease in electronic equipment; lubricant for electric cable prior to its being drawn through conduits, harness, etc.; release agent in moulding and casting operations; packing grease for glands and for impregnating asbestos packings to prevent sticking of joints; glass stop-clock lubricant; lubricant for preventing sticking of screw threads, e.g. with electric fittings located outdoors; vacuum sealing grease.



AEI germanium rectifier equipment, consisting of two cubicles each rated 1·4 MW, 10 000 amp, 140 volt

Germanium Rectifiers for Chlorine Production

Although both germanium and silicon rectifiers are being used for low-voltage electro-chemical installations in continuous day and night service, it is perhaps not widely known that germanium rectifiers offer substantial economies by virtue of their smaller losses. The following details of a germanium power rectifier equipment manufactured by the Heavy Plant Division of Associated Electrical Industries Limited may be of interest.

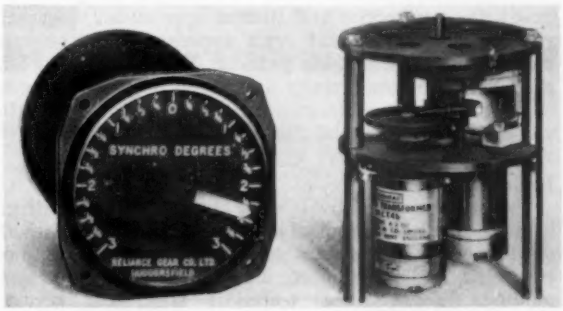
AEI has built a number of germanium power rectifier plants for chlorine production, the largest of which is rated 18·4 MW, 80,000 amp, 230 volt d.c. for the Ellesmere Port works of The Associated Ethyl Company Limited. Another example of such a plant, described below, is one supplying 20,000 amp load at 140 volt, which will soon be commissioned in South Africa, to operate in parallel with other converting equipment. This will be installed at the Umbogintwini (Natal) Chlorine Works of African Explosives and Chemical Industries Limited. The whole of the plant, including a.c. switchgear and control, power factor correction equipment, voltage regulating unit, rectifier transformer, rectifiers, and output and control panels, will be housed in an indoor substation occupying approximately 1300 sq ft.

The equipment will be controlled by one voltage regulating unit supplying a rectifier transformer, the load current being automatically controlled by varying the d.c. voltage between 140 and 90. A series-parallel connexion in the transformer winding allows the equipment to be used between 70 and 45 volts d.c. The entire equipment is designed to provide continuous operation for twenty-four hours per day, 365 days per year.

Two rectifier cubicles each rated at 1·4 MW, supply the d.c. output. Each cubicle has closed air-circuit cooling, and a built-in air-water heat-exchanger, so that corrosive gases, fumes, and dust are excluded from the cooling medium. The cubicle air temperature remains below 40° C when water at a temperature of 28° C circulates through each cooler at a rate of 1000 gph. The floor area occupied by the two rectifier cubicles is only 31 sq ft and the volume per megawatt is represented by a 4·6 ft cube.

The equipment is arranged for either hand or automatic current regulation, the latter compensating for supply system fluctuation or disturbances. Under automatic control, a constant-current control-circuit receives its signals from a set of high-accuracy d.c. current-transformers (sometimes referred to as transductors). By making a simple adjustment the operator of the electrolytic plant is able to set the total output current to within $\pm 1\%$, and after that the constant-current control is fully automatic. This can be done on the normal d.c. voltage range or, by paralleling the main rectifier transformer phases, on half-voltage range.

The rectifier cubicles contain a six-phase double-star connexion of germanium rectifier cells on air-cooled extruded aluminium cooling-fins, and parallel path protection fuses and transformers for fuse rupture indication circuit, all mounted on six trays per cubicle. Any tray can be withdrawn for inspection simply by loosening the a.c. and d.c. busbar captive connexion bolts, disconnecting the fuse indicating circuit plug, and placing the tray support in position.



The Reliance modular servo gearbox showing, at right, the standard plate mounting of the rotating components

Modular Servo Gear Boxes

The simplified modular construction of the servo-gearboxes made by Reliance Gear Company Limited, Almondbury, Huddersfield, utilizes standard plates for mounting rotating components. The basic module is a gear-box conforming to DEF 5000, wherein up to seven shafts are mounted in ball bearings. The construction is corrosion-resistant throughout and ball bearings are to ABEC, friction-tested to EL.1889 and double shielded, case-sealed against dust in a dust-free assembly shop.

Gear ratios are up to 43,000,000:1, using precision gearing to Admiralty Class 1. Accommodation is provided for up to six components—servo motor, potentionmeters, synchros, etc. Ratios and components are interchangeable for bread-board and prototype work. Shafts are extendable at both sides at any intermediate gear pass. Torque-limiting slip clutches are used in all ratios. An eddy current drag damper is available.

There is zero backlash in all ratios due to using spring-loaded split gears, shaft-clamped for maximum concentricity and interchangeability. The solid gear backlash in 1:1 ratio is 15 minutes of arc maximum.

An Experiment in Education

It is one thing to impart knowledge to apprentices and to develop their skill, but it is quite another to discover talents for leadership and initiative. British Timken may have found a way of doing this, as this account of a recent experiment suggests.

By D. J. LISTER, M.A.(Cantab.), Education Officer,
British Timken Division of The Timken Roller Bearing Company

THE British Timken Division of The Timken Roller Bearing Company has a large thriving apprenticeship scheme. The Company is proud of its educational facilities and is continuously reviewing its existing methods and seeking new means of improving them. It recently instituted a further experiment at the Duston factory with the main objectives of improving the self-confidence, clear thinking, and sense of responsibility of senior apprentices.

The experiment was organized in the following way:

Senior apprentices class

A senior apprentices' class was formed, consisting of graduate, commercial and student apprentices, together with all technician and craft apprentices in the last eighteen months of their training. The numbers in the class varied between thirty and forty, because of sandwich course attendances, etc. There was one lady student apprentice in the class.

Lecture series

Twenty-one executives were persuaded to deliver lectures on their responsibilities and the work of their departments. The lectures took place at a rate of one per week, and the subjects included safety, production methods, development, technical sales, and service engineering.

Projects

The projects for the apprentices were, briefly:

(1) Chairman to the lecturer;
(2) Chairman in the committee session;
(3) Secretary in the committee session;
(4) Re-deliver lecture to junior apprentices and prepare printed précis;
(5) Lecture to senior apprentices.

Chairman to the lecturer.—One of the senior apprentices was selected each week to act as chairman to the executive during his lecture. This involved contacting the executive a few days before the lecture to obtain a short career history from him, introducing the lecturer, controlling the question and answer session after the lecture, and making an appropriate speech of thanks at the end.

Committee session.—Following each lecture, the class of senior apprentices was split into two committees. A chairman and secretary were then selected for each committee. The job of each committee was to prepare a précis of one half of the lecture, one committee dealing with the first half, the other with the second. The duty of the chairman was to guide them in their consideration and discussion of the points made by the lecturer. The secretary was to make notes and prompt his chairman when necessary.

Re-delivering the lecture.—After the committee session, another senior apprentice was then selected to re-deliver the executive's lecture to the junior apprentices at a later date. He would have the précis produced by the two committees, the lecturer's notes and visual aids, and his own notes made during the lecture, to help him in doing this. He was also allowed to approach the executive concerned, to check any dubious points and to ensure that his information was accurate.

Printing a précis.—Having re-delivered the executive's lecture to the junior apprentices, the senior apprentice would then be responsible for producing two hundred copies of a complete précis of the executive's lecture. This would involve: (a) writing the précis, (b) checking the précis with the education officer for grammar, spelling, etc., (c) checking the précis with the executive for technical accuracy, (d) liaison with the typists' pool for cutting the stencil, checking proofs, and verifying the final copies.

Lecturing to senior apprentices.—The most senior apprentices (such as graduates) were also required to deliver a short lecture of their own choice to the senior apprentices. This lecture was given during the half-hour before the beginning of the main lecture each week. No restrictions were placed on the subject chosen, although the senior apprentice selected was required to inform the education officer of his choice of topic before preparing his lecture. Subjects selected included cost accounting, unit trusts, car racing at Silverstone, Canadian sports, modern architecture, brine mining, surface measurement, industrial psychology, the equality of women, and trades union history.

It is worth noting that the senior apprentices' class formed a very difficult lecture audience on account of its composition, since craft, technician, student, commercial and graduate engineering apprentices all have widely differing backgrounds and interests. Even an experienced lecturer might have found it difficult to keep all sections of the audience interested.

Selection of apprentices for the different projects

The chairman to the lecturer and the senior apprentice lecturing to the senior class, were nominated a week in advance. The committee chairmen and secretaries were nominated *at the end* of each main lecture, and the apprentice to re-deliver the main lecture to the junior apprentices was only selected *after* the committee session.

This was an essential part of the organization of this experiment. Lack of warning of what was in store for him ensured that each apprentice paid close attention to what the lecturer said and made copious notes. The method of selection was deliberately not systematic, to prevent any prediction by individual apprentices.

Objectives of the experiment

The use of public speaking, committee work, etc., to train apprentices in self-confidence, responsibility, and clear thinking, is not in itself new. The novelty of this experiment is its integration, its economy, and the many things accomplished in a short time span.

There was, for example, much dissemination and absorption of fundamental technical information. The substance of the technical lectures given by the executives has been preserved for future apprentices by means of the printed précis. Many of the executives concerned have had copies of the précis to keep for trainees other than apprentices who may pass through their departments.

There has been a gain, too, in human relations. Apprentices have been brought into intimate contact with very senior officials of the company. They have learned something of the adult philosophy of each successful executive as he talked about himself and the work his department is doing. They have worked with executives in preparing the chairman's notes, or the précis of the executive's lecture.

The senior apprentices' class itself has had an educational influence upon its own members. The craft apprentice has learned to respect and value the theoretical approach of the graduate engineer. The graduates have noted with interest the practical common-sense and grasp of detail of the craft apprentices. Potential draughtsmen have mingled with potential toolroom engineers. Commercial apprentices have discussed technical topics, and technicians have been forced to consider commercial points of view.

The senior class undoubtedly contains some of our future supervisors and executives. We believe that they will be a better team ten years hence, as a result of their new understanding of the other fellow's viewpoint, than they would have been if they had not taken part in this experiment.

Postscript

As a follow-up to this lecture-series, an apprentices essay competition has been organized. Four prizes of £10 each have been offered for the four best essays submitted on our manufacturing processes under the following headings:

1. Machining
2. Grinding
3. Press-work and heading
4. Heat treatment.

The essays must contain at least 3000 words and reach a definite conclusion. They must not be merely descriptive.

The Bicera Variable-ratio Piston

Results of full-scale engine tests

THE compression and expansion ratios of a piston engine are usually equal, and are given by the full volume of the cylinder divided by the volume to which the contents are compressed at the end of the compression stroke. The compression ratio has normally a fixed value in any given engine whether petrol or diesel and in the design of an engine is one of the most important choices to be made as it conditions the charge for combustion and its equal and opposite ratio largely determines the efficiency of the engine.

In the petrol engine the ratio is made as high as is possible without causing detonation when the throttle is opened.

It should be noted that at part throttle openings much higher compression ratios could be used in the petrol engine with a corresponding improvement in efficiency.

The real requirement of the petrol engine is thus for a variable compression ratio, and it is only for want of a satisfactory and sufficiently cheap means of varying the ratio that a fixed ratio is normally used.

In the naturally aspirated (i.e. unsupercharged) diesel engine, the fixed ratio chosen is usually a compromise between a high value which gives the best cold starting and the somewhat lower value which gives the most satisfactory conditions for long engine life at high load and low first cost. In the pressure-charged (i.e. supercharged) engine, a lower value of compression ratio is chosen with some loss of cold-starting ability and part load performance, in order that the maximum cylinder pressure reached at high outputs shall not impose excessive loads on the structure and moving components of the engine. Unlike the petrol engine in which

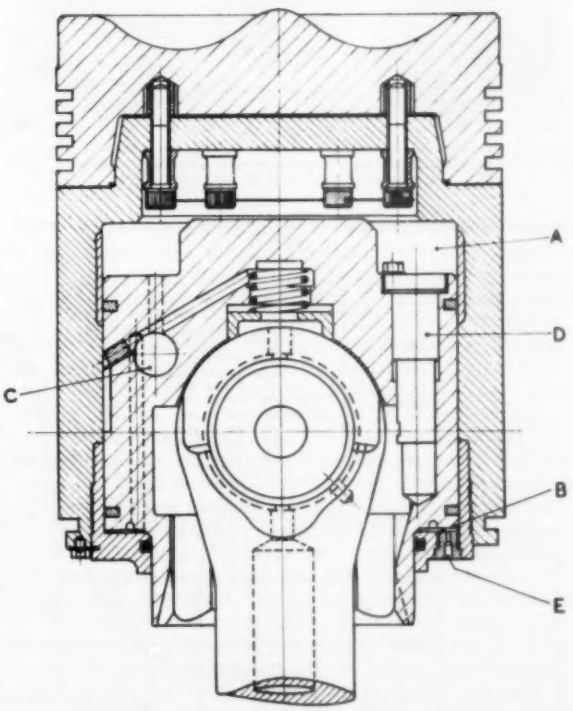


Fig. 1.—Sectional Bicera piston. A, upper oil chamber; B, annular lower oil chamber; C, bore (two non-return valves mounted on the bore); D, one or more spring loaded relief valves; E, fixed discharge orifice

detonation severely limits the possibility of pressure-charging, the diesel engine has a remarkable basic ability to consume increased quantities of fuel and air and develop correspondingly greater power, but because of certain secondary problems this is not easily accomplished. If these secondary problems are overcome three times the power of the naturally aspirated engine can be produced. As engines are developed towards high-power conditions, the use of a compromise ratio becomes increasingly unsatisfactory.

Even when the ratio is reduced to the bare minimum necessary to obtain cold starting and satisfactory running at light loads, the cylinder pressures reach such high values at the maximum load, that the engine structure and running components must be made extremely strong. In spite of the resultant added weight and cost the factors of safety at which the bearing surfaces in such an engine operate, must be less than if these very high pressures could be avoided.

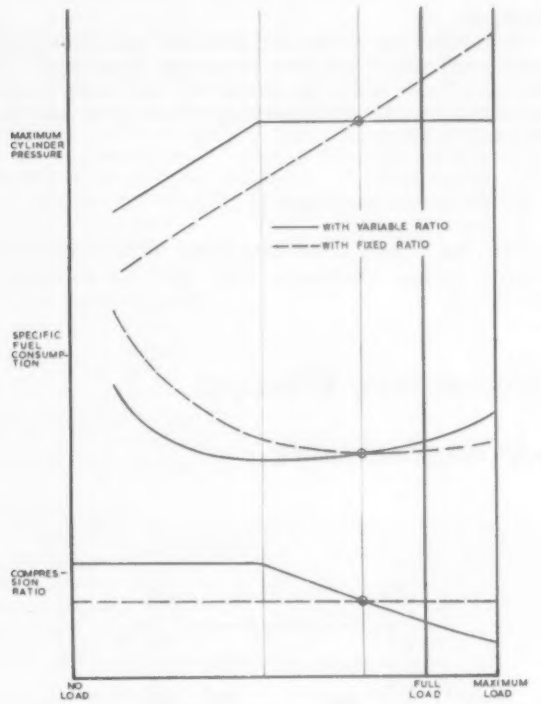


Fig. 2.—Performance comparison of Bicera variable-ratio piston and ordinary piston

The Bicera variable-ratio piston was developed as an aid to high pressure turbocharging and a characteristic of turbocharging is that the charge increases with increasing load. This is advantageous in that the air supply tends to keep pace with the demand but together with an increase in fuel it results in a rapid rise in maximum cylinder pressure as the load is raised. If the compression ratio is to be fixed, it must be fixed at a value high enough for reliable starting, smooth idling and reasonably economical low-load running, and this ultimately limits the charge pressure that can be safely used for full load, and therefore the full load itself.

By automatically adjusting the compression ratio in accordance with the load, the Bicera variable-ratio piston greatly extends the load range of an engine of given strength without sacrificing good starting, idling, and low load running.

This piston is therefore a contribution towards solving the problem of high mechanical loading in highly pressure charged engines. The piston's function is to limit automatically the maximum cylinder pressure to any value which may be selected as a basis of engine design having regard to all influencing factors.

The piston, of which a cross-section is shown in Fig. 1, consists of two main components, the piston (outer member) and the gudgeon-pin carrier (inner member) with limited relative movement between them. This relative movement, whereby the value of compression ratio is adjusted, is produced by the action of the maximum pressure of the gases upon the lubricating oil in an upper chamber, and an annular lower oil chamber. The movements of oil are effected in the following manner. Oil from the passage in the connecting rod is fed under pressure to two non-return valves mounted on a bore and then flows via passages to the upper or lower chamber, as one or the other increases in volume.

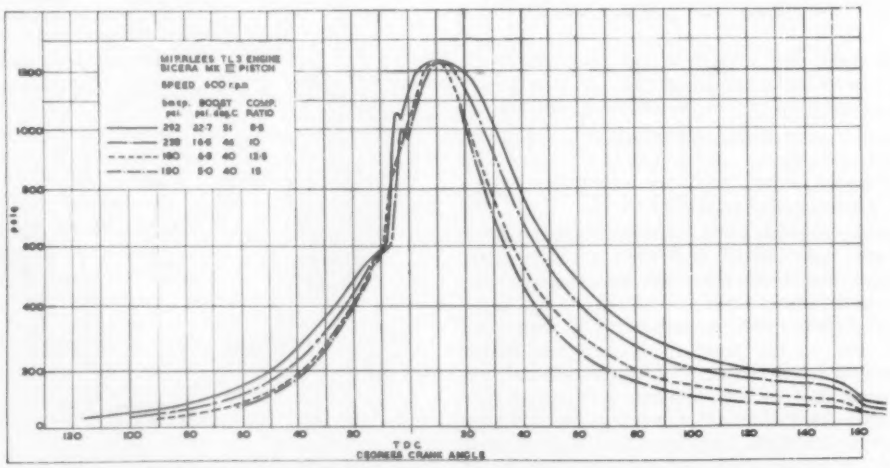


Fig. 3.—This shows the cylinder pressure curves obtained in tests of pistons of the design shown in Fig. 1 in an experimental three cylinder engine of 8.5 in. bore running at a mean piston speed of 1375 fpm

This arrangement ensures that both chambers are at all times full of oil. The upper chamber is provided with one or more spring loaded relief valves through which oil is discharged to the engine sump, when the pressure in the upper chamber due to the pressure of the combustion gases momentarily exceeds a selected pressure. A certain leakage of oil from the lower chamber is permitted via a fixed discharge orifice.

The action of the Bicera variable-ratio piston is as follows:

During the latter part of each exhaust stroke and the first part of each induction stroke, the inertia force of the outer member makes it overshoot slightly so compressing the oil in the lower chamber and forcing some oil out of the discharge orifice. A small upward relative movement of the outer part therefore occurs, which of course is dependent on the size of the orifice chosen and in the case of an 8·5 in. dia piston amounts to 0·004 in. When the load on an engine fitted with such a piston is reduced, so that the maximum cylinder pressure has temporarily fallen below the selected value at which it is required to be held constant, the small upward movement occurs on each cycle raising the compression ratio until the maximum cylinder pressure reaches a value which is just sufficient to cause the spring loaded discharge valve serving the upper oil chambers to open and discharge oil, so that a small downward relative movement of the outer part occurs.

Thereafter, until a further change of load occurs equal upward and downward movements of 0·004 in. occur, so that the piston remains at a substantially fixed setting, giving the desired maximum cylinder pressure. If the load is next increased so that the maximum cylinder pressure tends to rise above the selected value, the discharge of oil from the upper oil chamber will suddenly increase so that there will be rapid downward movement resulting in a lower ratio setting which maintains the desired limiting value of maximum cylinder pressure. In the lower load range where the maximum cylinder pressure is less than the limiting value selected the piston remains in its maximum ratio position.

The performance comparison in Fig. 2 shows how the piston changes the compression ratio as engine load changes, and its consequent pressure and specific fuel consumption. The broken lines show the corresponding conditions in an engine having a fixed compression ratio. The fixed ratio must be a compromise between the conflicting requirements of starting and light load running on the one hand, and running at maximum load on the other.

This usually means using the lowest ratio at which satisfactory starting can be achieved at low temperatures, but even then for a given output the fixed ratio engine must be designed to withstand much higher pressures at maximum load than the variable ratio engine. As the fuel consumption curves indicate, the loss of efficiency due to the use of lower ratios at the higher loads would be offset by the improved efficiency due to the provision of higher ratios at part loads.

The overall result is that the Bicera variable-ratio engine is a better starter, weighs less and is more reliable.

The piston itself is more reliable than a conventional piston operating at high outputs, not only because it carries smaller gas pressures, but because the outer portion which bears against the cylinder walls is a plain cylindrical part free of the distortion which the gudgeon pin bosses of a normal piston produce, and because the gudgeon pin and its associated bearings are arranged in a part which is free of thermal distortion being insulated by the oil in the upper chamber it operates at a relatively low temperature.

Pistons of the design shown in Fig. 1 have been used in a pressure-charged three cylinder engine with 8·5 in. bore of long-established design. They enabled an output three times that of the engine in its original naturally aspirated condition to be obtained with over-stressing.

Centrifugal Clutches

A wide range of "Ribble" automatic spring controlled centrifugal clutches originally designed for individual requirements, has now been developed by B. & F. Carter & Co. Limited, Albion Works, Bolton.

When using an electric motor as a prime mover, the centrifugal clutch enables the designer to utilize the squirrel cage type, with economical direct-on starting and the advantages of this kind of drive. It takes the load smoothly and gradually right up to operating speed without shock and any form of overload will cause the clutch shoes to slip. Direction of rotation can be reversed as often as desired. The Ribble clutch has been designed with an eye on simplicity, the friction faces are bonded to the weights, and it is self-lubricating.

The advantages of the squirrel cage motor can be obtained with almost any drive by use of the Ribble clutch. Operation is entirely automatic and the load is taken up smoothly right up to operating speed

The four main components are: driving member, clutch casing, loose weights (of which there are four) and cover plate. The fixed driving member has four arms which restrain the weights during rotation, these being retained axially by the casing and the aluminium cover. A flat steel spring passes freely through each weight, with the ends fitting into slots at the extremity of the four arms. An adjusting screw tapped through the inner face of each weight, exerts a pressure against the spring to hold off the weight, the screw being fixed by a locknut. Weights are all individually balanced after the friction lining has been bonded. The casings are made from a high tensile close grained cast iron, and are bushed with self-lubricating oil-impregnated phosphor-bronze sleeves which completely eliminate the need for lubrication. Flat springs are of high carbon steel hardened and tempered to a suitable degree and fit easily into the slots of the fixed driving member. The cover plate is of aluminium and is fitted by four screws with spring locking washers. Operation is automatic in action after initially adjusting the flat springs. These are normally adjusted at the factory to take up load at approximately 75% of full speed. These clutches are available from 1 hp at 1400 rpm to 9 hp at 1400 rpm. Other sizes are made to order.

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Conveyor Lifting Jack

The Engineering Establishment of the National Coal Board, in collaboration with the staff of Bestwood Colliery, Area No. 6, East Midlands Division, has designed and manufactured a conveyor lifter for quick and easy elevation of armoured face conveyors for horizon fixing and for inspection of the chain on the return side of the pans.

To advance an armoured face conveyor horizontally, double-acting rams are used, powered by a water emulsion pump located in the gate road. On the other hand the vertical movement required to fix the horizon is usually achieved by means of a commercial type lifting jack. This method has several disadvantages. Firstly, the operation of the jack is the full-time occupation of one man on each face. Secondly, in the event of a breakdown, with only one jack on the face it often takes a full shift to locate the point where the chain is broken or staked. Thirdly, the use of such a jack has serious drawbacks in low seams, where the operating lever has to be very short.

The Bretby conveyor lifter consists of a jack which is designed for incorporation with a ram, so that the combined piece of equipment can be used for all the required operations. Figs. 1 to 3 show the jack combined with a Bonser ram, but any other type of ram could be used as the basis of the conversion.

The jack itself has a malleable iron housing, on the front of which is integrally cast the slotted lug for attaching the jack to the standard spillplate, the ends of the housing being closed by spigoted steel caps.

Working inside the honed bore of the housing is a one-piece piston and rod; a circular footplate is attached to the bottom of the piston rod by two capscrews. The piston head is sealed by a rubber O-ring and the piston rod end is similarly sealed by a rubber O-ring mounted in the bottom cap. This lower seal and piston rod are protected by a rubber wiping seal which cleans the rod when the jack is being retracted. Drilled holes in the housing direct fluid to the upper or lower side of the piston.

To convert a standard Bonsor ram so that it will accept the jack, it is necessary to remove the two lifting lugs and machine a smooth vertical face on the ram head. Four capscrews are then used to hold the two units together. The standard valve housing is replaced by a new unit, mounted on the same two screws but incorporating extra drillings to perform the additional functions. Operation of the control handle, which is shown in the neutral position in Fig. 1, then gives the following sequence of operations.

Handle East, jack retracted, extend ram: handle South-East, jack retracted, retract ram: handle South (neutral), jack and ram retracted; handle South-West, elevate jack, ram retracted; handle South (neutral), retract jack, ram retracted.

In all positions the underside of the jack piston is fed from the pressure supply. This ensures that when the top of the jack is open to exhaust there is sufficient pressure on the underside to oppose return line back-pressure which would otherwise elevate the jack.

To protect the valve unit from damage, a new guard has been designed. It is supported at the front on the jack housing, at the rear by the ram housing, and along its length by distance pieces off the ram tube. The flexible ram feed pipe is still used, but has been moved to one side to reduce the height of the installation and facilitate travelling along the face over the rams, particularly in low seams.

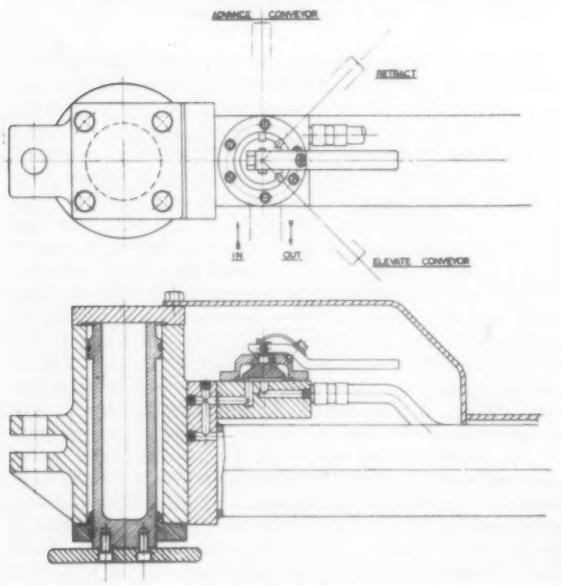


Fig. 1.—Bretby conveyor lifter

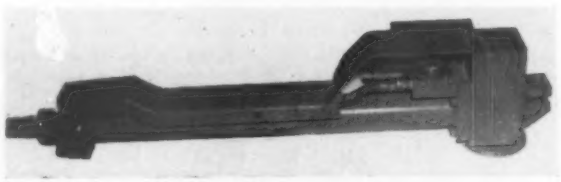


Fig. 2.—With jack retracted

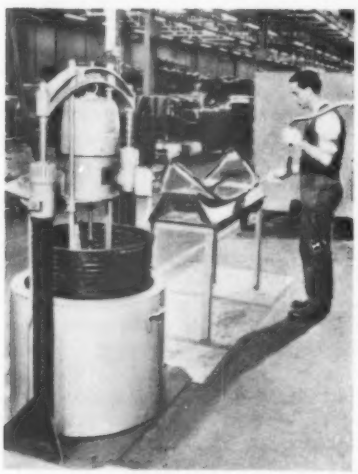
Fig. 3.—With jack elevated

Particulars of the unit are: type—double-acting jack; fluid—oil and water emulsion; stroke—6 in.; bore—3 in. dia.; lift (at 1000 lb/sq in.)—2·19 tons; overall height (retracted)—10¼ in.

The usefulness of the installation has been proved by experience underground at Bestwood Colliery, where one face is fully equipped with 30 rams. On this face the combined units are set at seven-yard intervals and the simultaneous operation of three adjacent jacks lifts the conveyor complete, with little catenary effect on the conveyor between the jacks. This facilitates inspection of the bottom chain, and 80 yards of chain have in fact been replaced in only 1¼ hours on this face.

Power Extrusion of Sealing Compounds

An interesting extrusion and sealing problem was solved at Vauxhall Motors Limited, Luton, by the installation of a series of air operated Graco pumps mounted on pneumatic rams. The material to be handled was Sealastic, used for the sealing of windscreens, back lights and weather strip assemblies. The problem was to dispense and extrude this heavy material quickly and easily at several points on the paint line.



Pneumatic unit for dispensing heated sealing material

The material is delivered in open top drums of 40 gal capacity and these are jacketed with Isopad heater units. A total of five pumps are used, each mounted on a pneumatic ram. The pumps have a pressure ratio of 40 to 1, so that an air pressure of 75 psi yields a material pressure of 3000 psi. The material is pumped direct from the drum through ¾ in. bore flexible hose to an overhead steel manifold 1½ in. bore × 30 ft long. From this manifold, take-off lines are dropped, each comprising 16 ft of ¾ in. hose plus a 6 ft tail piece (½ in. bore) to give added flexibility and terminating in an extrusion gun. Four guns are taken off each system, which is independently operated by one pump.

The pneumatic ram, also operating at 75 psi air pressure, is used to elevate the pump when loading and unloading drums, and it also applies a steady pressure to the ram in the drum when pumping takes place.

The system means that a heavier bodied material can be used than would otherwise be possible, and this in turn makes the process both quicker and cleaner. The material can be pumped from the original drum, pumping from the top to obviate aeration and channelling of the material. The ram seals the material from dirt and scrapes the drum clean, using all the material in the drum.

The installation is thought to be the first of its kind in this country to operate on such a heavy-bodied material. Graco equipment is distributed in the United Kingdom by Alfred Bullows & Sons Limited, Long Street, Walsall.

Making Porous Battery Separators

Among development by Pritchett & Gold and E.P.S. Company Limited is the production of microporous P.V.C. Porvic battery separators. In the production of these separators Porvic strips 40 in. long are loaded on to Sandvik stainless steel band conveyors to be carried through a 20 ft tunnel filled with live steam. As they emerge from the tunnel they are flattened by sponge rubber rollers before passing under cold water sprays which set the strips so that they may be handled without distortion. The object of the operation is to remove wrinkles and to anneal and relax strains which have been built into the material in the prior processes of the manufacture. The conveyor belts are each driven by 1 hp electric motor powered by means of a Croft's worm gear and Varatio straight line gear box operating at 360 rpm.

Porous P.V.C. on a Sandrik stainless steel band is softened by steam and flattened under a roller before being 'set' under a water spray

Molybdenum Di-sulphide Reduces Engine Wear

Tests employing radioactive tracer techniques carried out by the Institut Francais du Petrole to assess the value of molybdenum disulphide addition to lubricating oils, have shown that 6% Molyspeed, manufactured by Rocol Limited, Rocol House, Swillington, reduced the rate of wear in a Renault Dauphine, driven in and around Paris in traffic conditions, by 64%. The study is reported in "Revue et Annales des Combustibles Liquides" (Vol. XII, No. 7–8, July–August, 1958, J. Thiery).

Diesel engine tests were carried out in a stationary Petter A.V.1 engine, 6% Molyspeed being added to a high grade Supplement I oil, with results:

	Total starting-up wear mgm	Rate of wear in running mgm per hr	Reduction in rate of wear
Supplement I oil (S.A.E.30) ...	0·49	0·72	—
Supplement I oil (S.A.E.30) plus Molyspeed ...	0·19	0·31	57% weight

Petrol engine tests were carried out in a Renault Dauphine car fitted with the necessary recording equipment, and run in traffic conditions in and around Paris. The basic oil employed was a high-grade premium motor oil containing conventional anti-oxidant and anti-wear additives, and

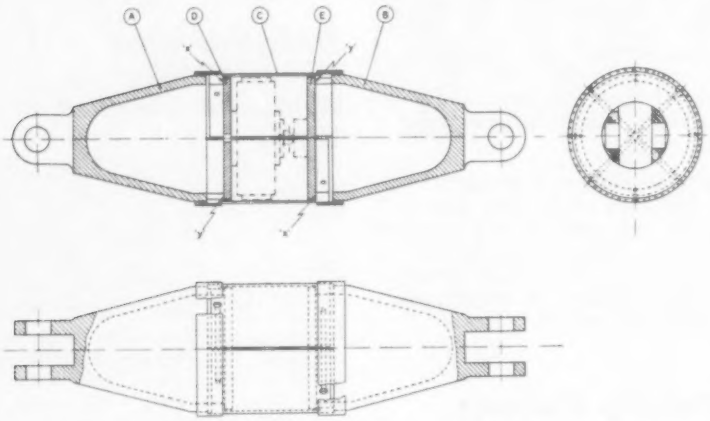
the following results were obtained:

	Total starting-up wear mgm	Rate of wear in running mgm per hr	Reduction in rate of wear
Premium motor oil (S.A.E.30)	2·9	2·5	—
Premium motor oil (S.A.E.30) plus 6% Molyspeed	2·2	0·9	64%

The basic oils already contained conventional anti-wear additives and the reductions shown are additional.

Drawbar Dynamometer

A hydraulic drawbar dynamometer, designed to operate under both compression and tension with no loss of accuracy, has been developed at the National Coal Board's Central Engineering Establishment. It is a compact instrument which operates a 6 in. dia gauge; the range of the instrument can be easily changed.



Drawbar dynamometer. The two interlocking halves enclose a capsule unit connected to a Bourdon gauge. The dynamometer works equally well in tension and compression

Basically the dynamometer consists of a hydraulic capsule so arranged between two thrust plates that it is compressed by the plates when the instrument is subjected to either tension or compression. This pressure in the capsule is transmitted to an indicator such as a Bourdon Gauge.

Most drawbar dynamometers operating on the hydraulic principle suffer from repeatability inaccuracies. This lack of accuracy is seldom improved when the instrument is designed to indicate both compressive and tensile loads. The C.E.E. instrument, which has been designed and developed for the testing of minecars and underground locomotives, has an accuracy in repeatability limited only by the accuracy of the gauge. It indicates compression or tension with equal efficiency.

In the accompanying illustration, parts A and B are identical end pieces, and D and E are two thrust discs. There are four identical segments (C), two of which are attached to each end piece at opposite sides of the periphery in such a manner that the segments form a cylinder when the two halves of the dynamometer are placed together.

The two discs (D and E) are mounted one on each side of a capsule unit, and the complete assembly is located between the inner flanges of the alternate segments. Countersunk tiebolts between the segment ends prevent spreading under load and a close fitting sleeve at each end maintains concentricity of the two halves of the dynamometer whilst allowing complete freedom of longitudinal movement.

The operation of the instrument is as follows. Under tension the end pieces A and B move apart, each end piece taking with it two of the segments C. The two discs D and E, being in contact with the inner flanges of the segments at 'X', are moved together, compressing the capsule which in turn operates the pressure gauge. Under compression the end pieces move together. The two discs, being in contact with the end pieces at 'Y', are moved inward, compressing the capsule and operating the gauge.

In each case movement of the two halves of the dynamometer relative to each other is extremely small. The capsule size is varied to suit the operating range of the dynamometer.

Flexible Seal Door for Mine Skips and Storage Bunkers

At the Central Engineering Establishment of the National Coal Board a flexible seal door has been designed by Mr. A. K. Barker, development engineer, which overcomes the sliding friction inherent in vertical steel-plated guillotine type doors used on skip containers and horizontal sliding doors fitted to bunkers. It consists of a flexible seal held across a discharge opening by a series of support rollers mounted in a movable carriage frame which can withdraw and replace the seal. One end of the seal is attached to the top edge of the opening and the other, after being inserted between the opening and the support rollers, is lapped around the first support roller and fixed to the movable carriage which consists of two side plates, joined by tie bolts forming spindles on which the rollers rotate, and is supported under an opening by a set of guide rollers. As the carriage is retracted the support rollers withdraw from the seal and the now loose seal is peeled away from the opening in the form of a loop, allowing the material to discharge; as it is advanced, the support rollers progressively replace the seal across the opening.

Since the action of withdrawing the support rollers is rotational and the seal peels away from the opening, friction between the door and the material stored is eliminated. The door is easily operated, requiring considerably less power than a conventional sliding door and overcomes problems of jamming or freezing; it is ideal for fitting to any bunkers containing fine granular material or material of an adhesive nature.

Fig. 1 shows a flexible seal door in its open position, fitted to a 16-ton capacity bunker for storing coal slurry; a similar door has been fitted to a coal washery refuse bunker and both have worked satisfactorily since their installation.

Using a flexible seal door weighing 300 lb to cover a 2 ft 6 in. wide by 4 ft 3 in. vertical opening on a 4-ton capacity skip container standing 16 ft high, the force required to open the door against a full load was found to be 710 lb. This low power has led to the development of a system for automatic opening and closing of the discharge door of a

travelling skip. A small door-operating cylinder is mounted on each skip and is controlled by a panel of valves shown in Figs. 2 and 3, which are arranged to produce a suitable sequence for automatic operation.

Fig. 1.—Flexible seal door in the open position

As the moving skip approaches its discharge station, it depresses a cam-operated valve (1) mounted on the guide tower framework, which allows air to flow into the female half unit (2), suspended in slides mounted on the guide tower, just before the male half (3), fixed to the top of a skip, enters and makes contact.

After contact is made, air passes through filter (4) lubricator (5) and into a second cam-operated valve (6) mounted on the skip, which, if the skip is in the correct discharge position, is depressed and allows the air to pass through a four-way valve (7) into the double-acting cylinder to open the door and discharge the material.

At the same time a T-junction off the main air supply line passes air through a secondary pipe line to a restrictor valve (9) and then into an air accumulator (10) which eventually puts air on one side of the spring-loaded valve (11).

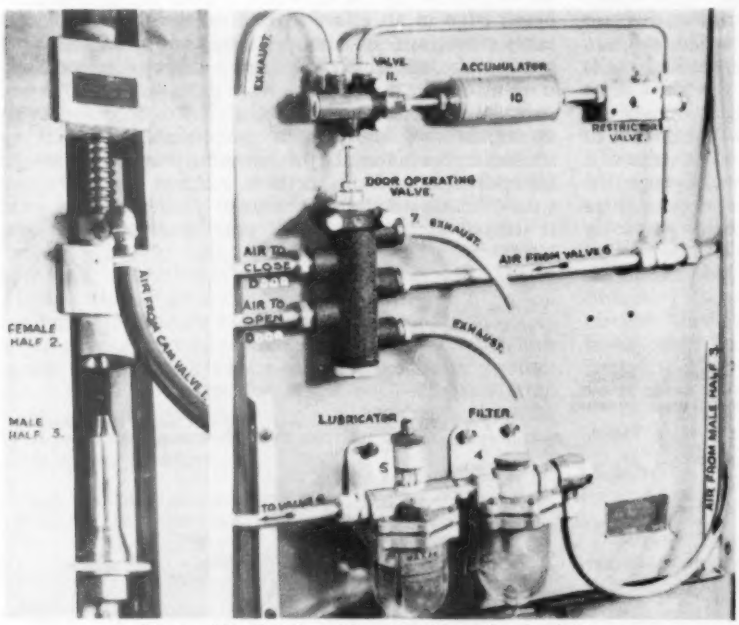
A third pipe-line by-passes these units (9) and (10) to supply air to the inlet port of valve (11) and when sufficient air pressure is built up in the accumulator, it depresses the spring in valve (11) and the force of air from the third pipe-line pushes down the plunger inside the four-way valve (7) to reverse the main air flow, which then passes to the other part of the door-operating cylinder and closes the door.

The air pressure in the cylinder prevents the door being opened again until the male-female connexion is broken by the empty skip descending. This then permits the air to exhaust from the system leaving it ready for a further operation when they are reconnected.

Adjusting the restrictor valve or accumulator size determines the period of time that the door is kept open and these can be fixed to suit the quantity of material being discharged.

A model of a skip showing the disposition of the flexible seal door, operating cylinder, control panel and male probe unit is shown in Fig. 4.

By suspending a female half unit in slides mounted on a headframe, fixing the male half probe to the top of a skip, and the door-operating cylinder and control panel on the skip body, an automatic discharge cycle is produced simply by raising the skip sufficiently to make connexion between the male and female units.



Figs. 2 and 3.—Control panel for automatic operation of seal door

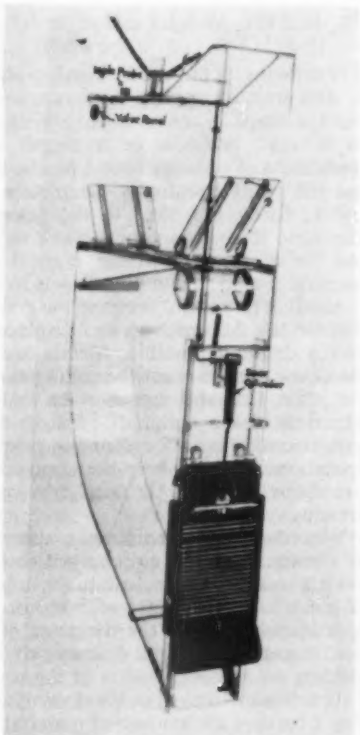


Fig. 4.—Transparent skip model with seal door and operating gear

A flexible seal type door can be fitted to existing skips without altering existing door-operating gear and the power required to open a loaded door reduced to only 710 lb. This in turn will reduce either the size or number of door-operating cylinders.

Alternatively, by fitting the automatic operating equipment to a skip, it eliminates the existing door-operating carriages and their supporting structure, which can be a great saving when large spans are involved or the steelwork support structure has to be mounted within concrete headframes.

Tools and Methods for Drawing Sheet Metal

Many factors enter into the process whereby flat sheet metal is drawn into hollow and perhaps intricate shapes. Their implications are embodied in the practice of tool design, the methods of which are reviewed in this article

By JOHN WALLER

IN drawing, a flat metal blank is placed in a press tool and pressure applied by a ram to a shaped punch so that the blank is converted to a hollow form which may be tubular, box-like or a simple shallow tray. The application of pressure causes plastic flow of the material, and the blank eventually completely fills the die cavity and so forms the piece to the desired shape. Such an alteration to the shape of a blank sets up severe stresses and for successful drawing, control of these stresses is essential if a good and true flow is to be obtained.

Another important factor is the grain size of a material, because the deformation and displacement of the grains makes drawing possible. Metals are crystalline and in the case of rolled sheet the rolling elongates and reduces the grain size and causes it to assume a longitudinal direction in the material. Thus in order to create the best characteristics for drawing purposes, an annealing operation is used to keep the grain size uniform. A grain size about 0·001 to 0·0015 in. gives mild steel an excellent drawing quality.

What happens when metal is drawn is best illustrated by the simple drawn circular pot shown in Fig. 1, which has a diameter of 3 in. and a depth of 2 in. For this size of pot a blank diameter of 5·750 in. is needed, a figure approximately twice the diameter of the finished shell; thus to assume the final diameter of 3 in. the blank must suffer a severe compression at the rim edge.

The production of a blank similar to that shown in Fig. 2 reduces the amount of material round the edge of a cup and when placed in a tool and drawn through the die a perfect shell without a trace of a stressed edge results. The arms on this blank have been purposely exaggerated in an endeavour to show the principle of these lines of movement, and proof is easily checked by making a paper model to the above-mentioned diameter and bending the arms upwards until they form the cup dimensions.

A further explanation is illustrated in Fig. 3 where A represents the blank radius and B the die radius, and for this example a section of about 30° has been chosen to exaggerate the condition sufficiently to show the principle clearly. When the blank finally slides over the die edge only the arc D is necessary yet the blank has an arc equivalent to C, and the two shaded portions represent unwanted metal which, unless rigidly controlled, would ruin the finish of a shell because of severe wrinkling round the top edge.

The application of pressure to a blank permits plastic flow past the yield point but not to a condition whereby ultimate stress is achieved and the blank fractures; thus as the blank slides over the die and into the cavity a thickening of the edge must occur from a point where the radius B commences. The material is thus in a state of tension during the operation as the grains are forced out of position by the die stretching the metal round the blank edge in an effort to remove the thickening that takes place, and this hoop stress, as it is called, is yet another factor which can result in broken pots by pushing out the floor.

It thus becomes apparent that if too deep a draw is attempted the reduction in the die diameter sets up stresses in the material by this ironing process, so that the ultimate stress of the metal is reached and it breaks, simply because it cannot eliminate the long shaded areas portrayed at Fig. 3—the deeper the draw the greater stress.

Fig. 1 (below).—Typical circular pot to illustrate the basis of drawn work

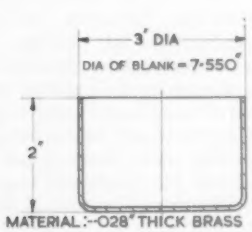


Fig. 2 (right).—"Lines of movement" for the pot of Fig. 1

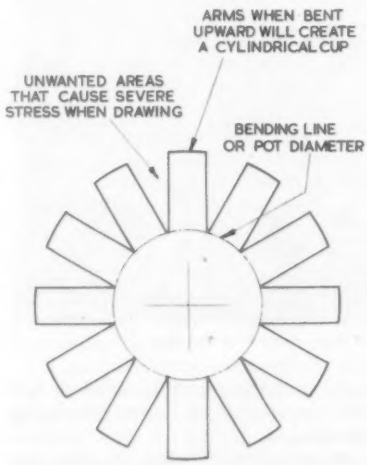

ARMS WHEN BENT UPWARD WILL CREATE A CYLINDRICAL CUP
UNWANTED AREAS THAT CAUSE SEVERE STRESS WHEN DRAWING
BENDING LINE OR POT DIAMETER

Fig. 3 (below).—Enlarged view of Fig. 2, indicating the highly stressed shaded areas

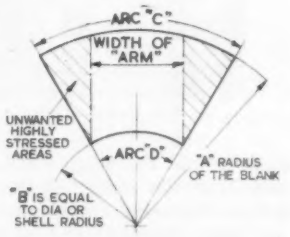


Table 1 gives the recommended reductions for the first and subsequent redraws for different materials provided the change in shape of the article being produced is not too severe. When the latter occurs the governing factor in determining the amount of reduction is largely a matter of experience and hard and fast rules are impractical. An excellent rule for the initial draw is a reduction of 40% from the blank size and this, as the chart indicates, applies for all materials.

Associated with this question of reduction is the radius at the die mouth—the draw radius to give it the correct name—and this can have a surprising effect on the drawing of a cup, especially if a very large radius is used for light gauge metal. The enlarged sketch Fig. 4 illustrates how the material passing in to the die can escape from the pressure pad much too soon and so produce wrinkling; thus the introduction of an angle to the article with the use of an angled die where redrawing is necessary, is preferred because it exercises a greater control over the metal. This idea is ideally suitable for double action presses.

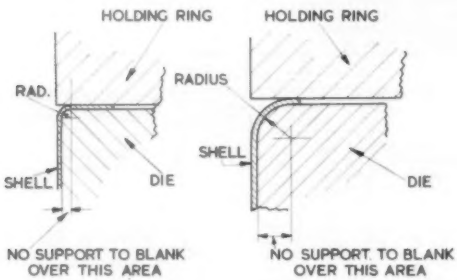


Fig. 4.—How the material can escape the pressure pad when the die radius is too large

Occasionally one encounters a component where one portion of the profile is difficult to draw successfully and any effort at increasing the draw pressure, while eliminating wrinkling at the spot where this section occurs, unfortunately may cause other parts to fracture. A localized pressure is thus essential, and this is obtained by using draw beads to restrict the flow at that point but without imposing too great a stress on the remaining portions of the shell. Again, differential flow is secured at varying places by using beads of different heights, but here the examination of a drawn component will indicate whether this is necessary. Fig. 5 illustrates a typical bead machined on the holder and die, a bead being simply a protrusion corresponding to a trough in the die, this creates a ridge in the blank and continued drawing causes the material to follow this shape until it passes completely into the die. Generally with box-like articles the bead is cut into sections while circular beads are left as a ridge round the aperture.

Table 1.—RECOMMENDED REDUCTIONS FOR THE INITIAL DRAWING AND SUBSEQUENT OPERATIONS

Material	1st Draw from Blank	Subsequent Redraws from Original Cup
	%	%
Aluminium		
Soft	40	20 to 25
Deep drawing	40 to 50	20 to 30
Brass	45	20 to 35
Copper	40	15 to 25
Steel		
Drawing	35 to 40	15 to 25
Deep drawing	40 to 45	15 to 20
Stainless	30 to 40	15 to 20
Tinplate	35 to 45	10 to 15
Zinc	50	15 to 20

Die clearances form another important factor in drawing because the material produced by rolling is made to certain tolerances, and these can effect the work of drawing unless considered when the tools are constructed. A 20% clearance is the total amount to allow on the tools as 10% is necessary for each side of the punch and die. The dimensions of the tools are obtained as follows:

A cup 6 in. dia is drawn from sheet material 16 gauge or 0·064 in. thick with a tolerance of $\pm$ 0·002 in. Thus the metal dimensions are 0·066 in. maximum and 0·062 in. minimum.

The punch dimension is, of course, 6·000 in. dia and this means the die size is 6·000 in. + 0·132 in. (twice the maximum metal thickness) and equals 6·132 in. dia.

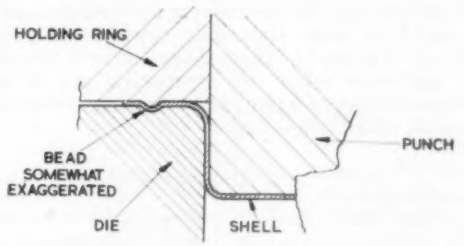


Fig. 5.—Drawing beads are useful in restricting metal flow and to remove wrinkles

To this is added the clearance of 20%—the latter being calculated on 0·064 in., and this gives 0·015 in.; which brings the die size to 6·182 in. (6.132 + 0·015 in.).

This method of formulating the die dimensions means that providing the tools are manufactured correctly to ensure that the punch is always centrally placed in relation to the die, there is enough room for the material and no 'nipping' occurs. For the final operation of drawing an opportunity is often taken to establish a definite size on a workpiece and to achieve this accuracy the clearance is reduced to a minimum, even perhaps to the extent where a slight tendency to iron the shell is created.

Before illustrating a set of suitable tools used for producing a deep drawn cup, some indication on the methods applied for obtaining the blank dimensions will be indicated as no production is possible until a satisfactory blank is secured. While the easiest method of obtaining the necessary diameter for a blank when a circular shell is required is to refer to tables in a text book which deals with this type of tooling, the formula for calculating these particulars are derived from:

$$D = \sqrt{d_2 + 4dh}$$

where D = blank diameter
d = shell diameter measured at the centre of the walls
h = height of the shell.

A quick approximation of a blank size is frequently necessary in order to determine the material width, and this is computed from the formula

$$D = d + h + \tfrac{1}{2}d$$

where D is the blank diameter, d is the diameter of the cup through the centre of the walls (the mean diameter) and H equals the height of the finished shell.

Frequently a shell may have a generous corner radius and this will demand a modification in the formula for determining the blank diameter. Such a blank is fairly

accurately calculated from the formula

$$D = \sqrt{d^2 + 4dh} - r$$

where r is the radius at the corner and h is the height of the shell. In applying this formula some care in selection is essential to see that the radius does not exceed one-quarter of the shell height.

Generally, the formulae for finding the blank sizes are based on:

(1) The equalization of the area of a completed shell
(2) The equalization of the volume of metal of a completed shell

and as most examples are deemed not to alter in thickness during the pressing, the area formula is considered to meet the requirements of most components.

Fig. 6 illustrates several types of circular shell together with the formulae for determining their blanks, and these are useful as often apparently complicated parts are made up of several of these shapes; thus it becomes an easy matter to select the appropriate set of shapes, calculate a series of figures and by adding them together a suitable blank size is found.

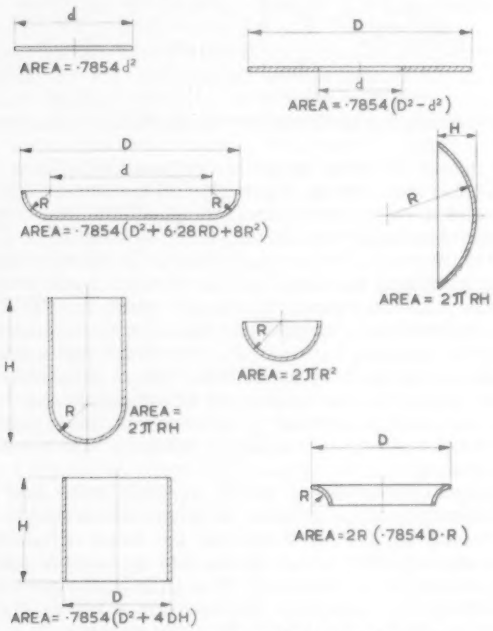


Fig. 6.—Formula for determining blank sizes

A typical case is depicted in Fig. 7—a flanged shell having a lower corner radius with a similar radius under the flanged diameter. An exploded sketch is useful in these examples to give a clear picture of the actual build-up of this shell as shown alongside the original drawing.

The production of rectangular or square boxes are cases where a little thought is needed in finding the blank because the operation is really a dual one necessitating bending of the sides and ends with a drawing process taking place in each corner. An example with the dimensions given on a blank is perhaps the best way of showing how this is accomplished, and Fig. 8 depicts the layout for a rectangular box of 10 in. × 8 in. × 2 in. depth with a 1 in. corner radius. The chain dotted lines show a plan view of the box with the four centres of the corner radii clearly drawn—an essential factor in any layout of this nature as they determine the final shape of the blank. The next step is to add the arcs using the quick approximation formula:

$$D = d + h + \tfrac{1}{8}d$$

gives $D = 2 + 2 + \frac{1}{8}(2)$ equal to $4\frac{1}{4}$ in., and as a small extra piece for trimming is usually necessary, a blank of $4\frac{1}{2}$ in. dia would produce a shell of this depth if drawn.

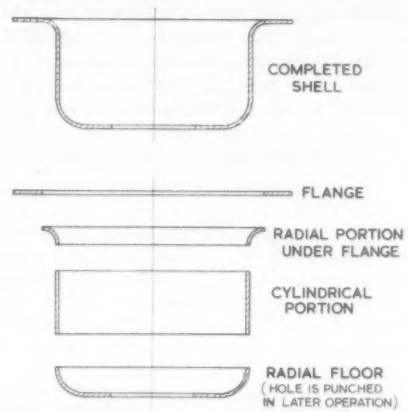


Fig. 7.—Flanged shell broken down into a series of simple elements for easy calculation of a blank diameter

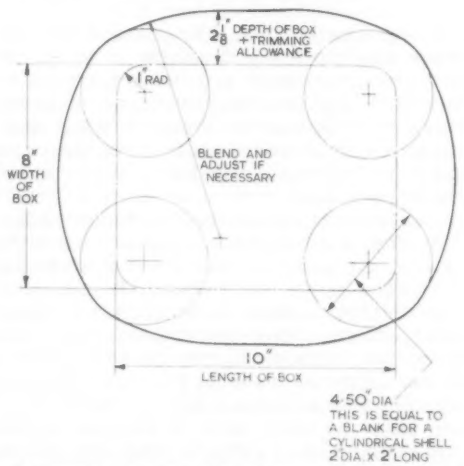

2⅛" DEPTH OF BOX + TRIMMING ALLOWANCE
1" RAD
BLEND AND ADJUST IF NECESSARY
8" WIDTH OF BOX
10" LENGTH OF BOX
4·50" DIA
THIS IS EQUAL TO A BLANK FOR A CYLINDRICAL SHELL 2 DIA. X 2" LONG

Fig. 8.—A rectangular box requires a layout drawing to ascertain shape and size of blank

Thus a circle is added to the layout on the assumption this latter stage is needed, and the length and breadth included as shown. Blending radii to join up the corner radii with the sides completes the shape.

Reverting to the circular style of blank where a long shell is required, the need for several draws to achieve the reduction means that the punch nose must conform to a given pattern, and undoubtedly the most convenient form is the angled type illustrated in Fig. 9, and by using the same centres of radii each punch complies to a standard method which culminates in a final component with the given corner radius.

Tapered articles also demand similar treatment and a funnel is produced in a series of stages each designed to increase the amount of taper until the final degree of angularity is reached without the bottom of the shell being torn away. In the initial draw a cup is produced generally on a double action press as shown at Fig. 10,

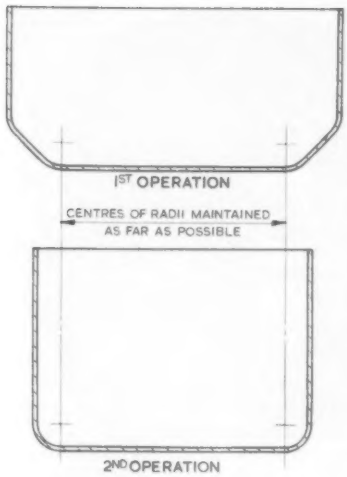


Fig. 9 (left).—When several draws are necessary the use of the same radii centres gives a smoother drawing action, and closer control of the blank size is assured

Fig. 10 (bottom left).—A funnel shaped component needs several workstages before the final depth of draw is accomplished

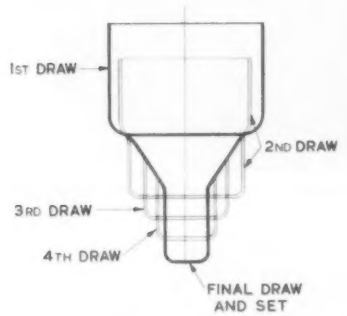
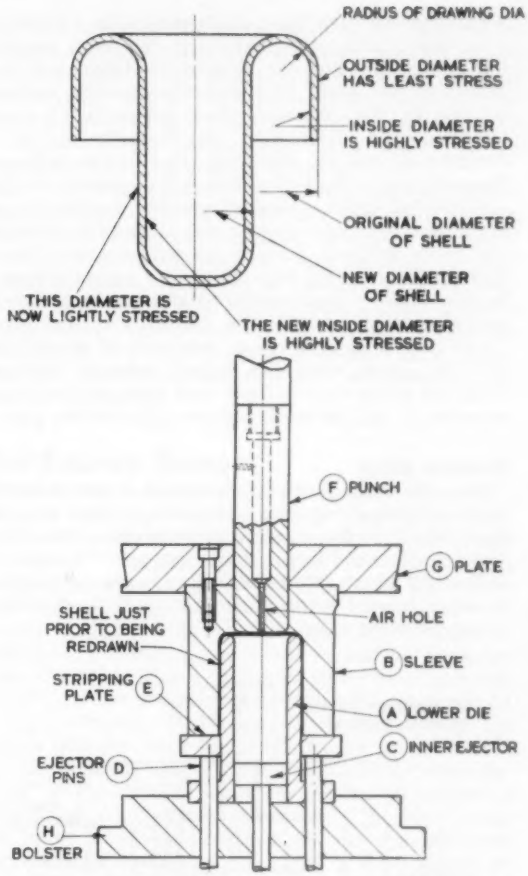


Fig. 11 (top right).—A partially drawn cup where reverse drawing is used. The method reverses the stresses set up in the metal

Fig. 12 (bottom right).—A reverse drawing just commencing to pull the cup into the die. The upper sleeve B completely surrounds the component and supports it during the process



and then subsequent reductions in this shell give a gradually tapering component until the final shape is reached; the last pressing operation is more in the nature of a set rather than a draw in order to smooth the profile and secure a true angle. Each stage is indicated on this drawing by overlapping the operations, but there is no great alteration in the shape, rather is there a tendency to flow each workstage into the following process and so avoid severe reductions which could introduce difficulties.

Reverse drawing

Reverse drawing has advantages for rapid production. Perhaps the chief advantage is the reduction in the number of annealing operations which the drawing of sheet metal makes necessary. In some cases the latter work is entirely eliminated and there is also the added useful factor of increasing the depth of each draw and so making it less costly in both tool construction and handling to produce an article.

Considerable research has been conducted during and since the war to find a satisfactory solution regarding the increase obtained by reverse drawing, which is, no doubt, due to the reversal of stresses set up at each stage of the process.

With orthodox drawing every further drawing operation increases the stresses which the initial process creates internally in the shell, until such time is reached when the metal can no longer withstand another increase and fracturing results.

Reverse drawing, however, tends to overcome this and the inclusion of another imaginary component indicates that each time a draw takes place, the highly stressed inner wall becomes the comparatively lightly stressed outer member. It is evidently this that allows increased drawing depth without fracturing. Fig. 11 illustrates a partially drawn cup suitably annotated to show its changing appearance.

A double action press is best for this type of pressing, and in Fig. 12 the previously drawn cup is placed on the outside diameter of the lower die A and the descending upper pressure sleeve B would in any case cause the shell to seat on the top surface of the die if the cup is slightly tight on the location.

The descending punch draws the material from beneath the pressure sleeve into the aperture, thereby securing a reduction in the diameter and at the same time making the previously drawn outer wall into the new inner member. An inner ejector C removes the now reduced shell from the die and deposits it at the top of the die. One obvious point about these tools is the importance attached to the radii—a true, perfectly smooth curve is essential to enable the metal to draw over the edge without any suggestion of hindrance which would increase the pressure needed for the operation.

Necking down

This is yet another method used for securing a reduction in the cup size on a single action press, and the way the work is handled ensures an article free from severe

wrinkling. Basically the tool shown in Fig. 13 consists of three main parts—the guide ring, the lower punch and the upper die—and the previously drawn cup is first placed on the guide ring where the outside diameter is ground to the necessary close tolerance to create a location. The descending die B performs the dual function of pushing the guide ring downwards and at the same time reduces the shell as the punch C is exposed until the full depth is reached whereby the now ascending die allows the guide ring to rise, under the influence of the lower buffer or cushion, to strip the shell from the punch. Pins inserted into the guide ring are ground to a length to allow the material to slide easily and without restriction between the die radius and the generous curve on the guide ring—a clearance of approximately 0·002 in. larger than the largest material thickness is sufficient as this ensures there is no tendency for the upper member to nip the work and so cause broken pots.

Pressure plates

For the drawing of thin material a flat plate of the type depicted at Fig. 14 is adequate and there is generally little fear that the material will wrinkle. However, the introduction of large diameter springs can cause difficulties where thin blanks or cups are handled as the pressure exerted is too great and the bottom of the pot is torn from the walls.

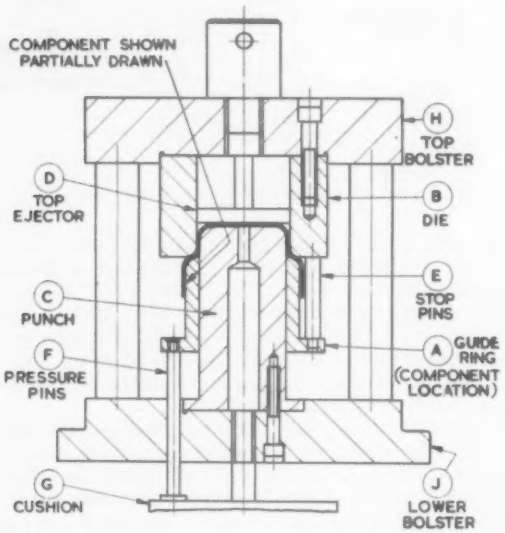


Fig. 13.—A necking down press tool used on a single action press. The work is seen about half completed

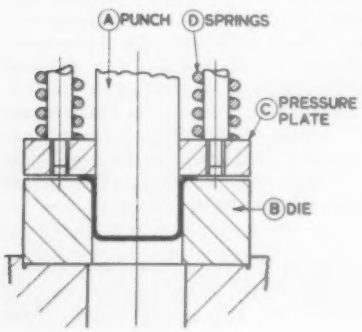


Fig. 14 (left).—A typical pressure plate used for thin material where the drawing pressure is never very high

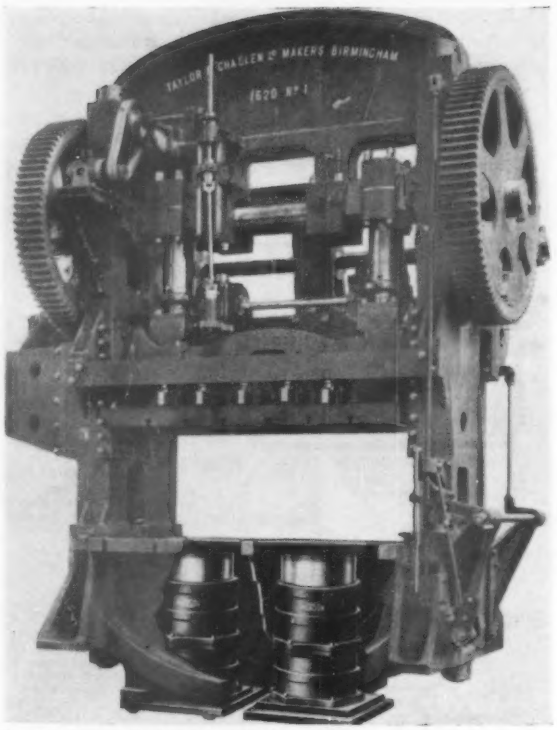


Fig. 15.—Worson 300-ton die cushion in use with a Taylor and Challen press

Often these plates are applied in conjunction with rubber buffers attached to the lower tool, and the latter part is made as a sub-assembly for easy dismantling for use on different tools. While a spring loaded pad is satisfactory for the upper member, the introduction of rubber needs careful consideration—in fact there is really little to recommend it as a pressure medium and many problems associated with poor drawing are traced to using rubber for blank holding. During drawing, excessive displacement occurs that increases the area presented to the buffer plate and this creates extra pressure on the pins operating the lower pad. Used simply as an ejection medium the rubber buffer is useful—a stripper ring is a typical example on a drawing tool used on a single action press—but for all further operations the pneumatic cushion is superior and for really deep drawing it is essential. Fig. 15 illustrates a Worson 300 ton double sided pneumatic die cushion which is popular for this type of press work, and the photograph shows it

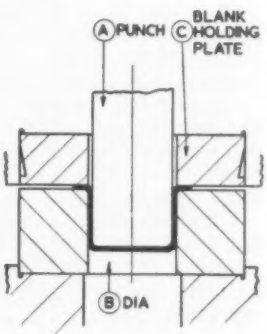


Fig. 16 (right).—Blank holding plate used on double action presses, here applied for a simple cup

fitted to a large Taylor and Challen press. Installations of this nature require considerable auxiliary equipment before they become operational, but once installed trouble-free working is assured.

For double action presses the blank holding plate is sufficient as depicted in Fig. 16, and the punch passes through the centre to draw the sheet from beneath. However, circumstances often make it necessary to provide a longer part—the design previously described in Fig. 13 is a typical example where this occurs—and it becomes a simple matter to locate a longer piece of steel in a recess and hold it by a series of screws as the former drawing shows.

Drawing pressure

On numerous occasions the component is so small that a determination of the pressure in order to find the size of press most suitable for that particular article is not necessary, and the tools are merely installed on the most convenient machine. When the shell diameters reach sizeable proportions a reasonably close estimation of the drawing pressure is essential to ensure that the tools are designed for the correct machine. The formula

$$P = T \times t \times D \times \pi$$

where P = drawing pressure, ton
T = tensile strength of material, ton
D = outside diameter of the shell, in.
t = blank thickness, in.

is generally suitable and is sufficiently simple to allow a quick calculation of the requisite pressure.

A typical example is to find the pressure for drawing a brass shell 6 in. dia of 20 ton material and having a thickness of 0·064 in.

$$P = 20 \times 0{\cdot}064 \times 6 \times \pi$$
$$= 24{\cdot}11 \text{ ton}$$

thus this component would require a press having a rating of approximately 30 to 40 ton as a 25 ton press is a little too close for safety.

Drawing speed

In many works the tool designer has no control over the speed at which the press is set for the speed of the ram. Unfortunately the setter hazards a rather rough guess taking into consideration previous jobs of a similar nature, and then runs the machine accordingly. If, however, some attention is paid to this matter, users of this type of press tool will find that this press ram speed is fairly critical—too high a speed does not mean faster production because this can create severe work hardening and subsequent annealing of the partially finished shells before further processes are possible.

A speed of between 25 to 30 fpm is apparently not a very wide range taking into consideration the many and often complex shapes produced by this method of pressing, but it will cover the most complicated jobs, and generally the size of the component has little influence on this question of ram speed.

In conclusion it is possible to state that in no branch of presswork does so much depend on the accumulated knowledge and experience of the designer in calculating the best shape for the preliminary operations, the various pressures at which to hold the material and, finally, the often neglected process of re-striking the blank in order to achieve a sharp and accurate profile. Sharpening the profile is an operation which can do much to relieve the work of previous tools—the pressing of almost a perfectly sharp corner in the bottom of a pot is only one instance where this is useful, but the addition of embossed details is possible on flanges and the lower faces of various pots. Slightly stretching the material is deliberately carried out without detriment to the finished article, but again experience plays an important role in determining exactly when and how much to elongate the metal for such operations.

One important factor which every designer must constantly keep before him is that the tools never cut, but always every attention is necessary to make the metal flow easily over the die edge and into the tool. Never at any time should a restriction be placed on the material that will prevent this easy flowing action other than the normal pressure associated with a cushion or pressure plate, and if this simple point is remembered, some, if not all, of the problems met with in drawing sheet metal will disappear.

Thickness Gauge

The Accuratest thickness gauge which aims to provide a rapid, non-destructive method of measuring the thickness of non-conducting coatings on non-ferrous basis metals was originally designed by Coloral Products Limited, and is now being marketed by Nash & Thompson Limited, Hook Rise, Tolworth, Surrey.

Measurements can be made over the three ranges of 0–0·0025 in., 0–0·005 in. and 0–0·01 in. and the thickness is read off directly from a calibrated meter to an accuracy of $\pm 10\%$ of the actual reading down to one-tenth of full scale deflexion. The gauge, which operates on the principle that the basis metal affects the inductance in the probe, requires only a few minutes warming-up time. The zero of the meter is set by placing the spring loaded probe tip on a non-coated specimen of the basis metal which must have the same profile as the anodized specimen to be tested and the probe is then applied to the specimen and the thickness of the plating read on the meter. To obtain correct readings, the measuring area must be at least of $\frac{1}{4}$ sq in. area. For production line work the probe is usually mounted in a jig with the specimen as the load. The gauge is mains operated and the meter is mounted on a sloping panel for easy viewing. The price is £128.

Rotary Compressors

French M.P.R. rotary compressors are now being made under licence by Belliss and Morcom Limited, Ledsam Street Works, Birmingham 16. These have a range of operation up to 50 psig for single stage machines and from 50 to 110 psig for the two stage machines, with outputs from 100 to 600 cfm in the first instance.

The compressors have a minimum of moving parts. Horizontal, free-sliding blades are mounted in longitudinal slots in a rotor and are flung outwards under the influence of centrifugal force, maintaining constant contact with the cylinder walls. The rotor, which is integral with the shaft, is eccentric in the cylinder but on the vertical centreline, an arrangement providing a free crescent shaped space divided into compartments by the blades; those on the inlet side gradually increasing in size in the direction of rotation and those on the delivery side gradually decreasing in size. Other features are: cylinder cast in one piece with integral water jacket, feet and inlet and outlet branches; heavy duty, high precision roller bearings carrying the rotor shaft, which is fitted with seals of the plastic axial type.

Three alternative mounting positions of the new Adaptable Type Radicon worm gear unit

New Radicon Worm Gear Units

A new range of Radicon worm gear units has been introduced by David Brown Industries Limited of Park Works, Huddersfield, covering centre distances from $1\frac{1}{8}$ in. to 8 in. and comprising two basic types, the "Adaptable" for centre distances of $1\frac{1}{8}$ in. to $3\frac{3}{8}$ in. and the "Solid Foot" type for centre distances of 4 in. to 8 in. These are allocated size designations of 112 to 337 for the Adaptable range and 400 to 800 for the Solid Foot type.

The Adaptable range covers seven sizes and gives power coverage up to approximately 10 hp. Units are characterized by the fitting of detachable feet, a feature which gives versatility of application and the number of different mounting positions is almost unlimited. Compared with the previous series, the new range includes four additional sizes. The range of ratios has also been increased and now extends from 5 to 1 to 70 to 1. A special "Drywell" cover is now fitted to the slow speed shaft and this, together with efficient oil seals on the high speed shaft, provides efficient oil sealing in all mounting positions.

Extensive external ribbing on the case end covers together with the cooling fan which has been fitted to these small units for the first time, has led to a substantially increased heat dissipation and this, together with the improved material for the gears, has increased the heat and mechanical ratings to such an extent that in most cases a smaller unit than hitherto will now suffice for a given duty.

So far the new range of Adaptable units covers only single reduction types but designs are now being prepared to cover double reduction units and motorized units. It is anticipated that production of these types will begin early next year.

The Solid Foot range comprises five sizes in three basic types and covers the requirements of drives up to approximately 80 hp. They are of the U-type where the high speed shaft is located underneath the slow speed shaft which is an ideal arrangement for the majority of applications, the O-type where the high speed shaft is over the slow speed shaft, and the V-type where the high speed shaft is horizontal and the slow speed shaft vertical.

In adopting a modern styling, opportunity has been taken to remove vulnerable projections and to make a big increase in the surface area available for cooling by providing additional ribbing. This, coupled with the introduction of a larger and more efficient fan, has led to increased thermal ratings and the heat ratings are over $12\frac{1}{2}\%$ better than the original units.

All the Solid Foot type units are interchangeable as units with corresponding Radicon units of the previous design but none of the individual components is interchangeable. Sizes 400, 600 and 800 are in accordance with British Standard Specification No. 3027: 1958.

The new series so far covers U and O type units and V type units will be marketed early next year, together with a range of first reduction helical units suitable for flange mounting to the Solid Foot type worm reducers and giving overall ratios of up to 280/1.

The new Solid Foot Radicon worm gear unit. Above Type U with high speed shaft underneath the slow speed shaft; and, shown, below Type O with high speed shaft over the slow speed shaft

Drawing Table

In the Admel Hemsley drawing table the drawing stand and counter-balancing mechanism are built in to the reference unit: it is fully counter-balanced, has front controls giving finger-light adjustment, takes all types of drafting machines, has ample drawer space, provides side and rear reference and is economical of floor space. It is marketed by Lawes Rabjohns Limited, Abbey House, Victoria Street, London SW1.

Q-Meters

The 'Q' of a coil or capacitor is a measure of electrical quality, the Q-factor of inductors largely determining the dynamic impedance of a.c. circuits as a whole. Measurement of Q-factor is usually done with commercial Q-meters. This article explains the principles involved and also describes two simple workshop methods of determining Q-factor when a commercial Q-meter is not available

THE quality or figure of merit of an electrical component is defined by the Q-factor or the ratio of reactance to inductance. Basically, the Q-factor at any frequency is a measure of the energy stored to the energy dissipated in the component under oscillatory conditions (at that particular frequency). Since all practical components have an effective resistance, however small, it follows that all components have a finite Q-factor, although this will be specific to a particular frequency. Temperature effects due to the difference in power levels are generally ignored.

Capacitors and inductors are employed in electronic circuits for their reactive action and any resistance represents a power loss and a loss of efficiency, hence the virtue of a high Q-factor signifying minimum resistive losses. Inductors, inherently, offer resistance and thus have a lower Q-factor than capacitors, and so of the two the Q-factor of the inductor largely determines the dynamic impedance of the circuit as a whole.

Pure resistance is quite distinct from reactance, which is sometimes confusingly, and erroneously, referred to as 'a.c. resistance'. When an alternating voltage is applied to a pure resistance the alternating current flowing through it is in phase with the voltage and follows Ohm's law (current = applied voltage/resistance). When alternating voltage is applied to a pure reactance the current resulting is consistent with the resistance circuit in that it equals applied voltage/reactance, but it is out of phase with the applied a.c. voltage. In the case of capacitive reactance the phase is leading; and in the case of inductive reactance the phase is lagging. To summarize: with pure resistance the a.c. current is always in phase with the voltage, but current is always out of phase in a reactance.

Alternating current resistance is not readily determinable like d.c. resistance for it varies with frequency and depends on a variety of factors—d.c. resistance, coil losses or dielectric leakage, skin effects and various other losses (including corona effects at high voltages). At very low frequencies a.c. resistance tends to be the same as d.c. resistance (and sometimes is taken as equal for convenience of calculation when the frequency does not exceed about 50–60 cycles per second). At higher frequencies a.c. resistance is invariably greater than d.c. resistance, and the higher the frequency the bigger the difference.

This represents a problem in determining the Q-factor since a.c. resistance cannot be measured simply and directly with any degree of reliability. Reactance can, however, be more easily determined and from this the a.c. resistance can be calculated if the Q-factor is known, viz.:

a.c. resistance = reactance/Q-factor.

Various instruments have been designed for the measurement of Q-factor direct, known as Q-meters (or circuit magnification meters), which are normally intended mainly for measurement of inductors because of the greater significance of the Q-factor with this component. Most can, however, also be used for determination of the Q-factor for capacitors. The main limitation of such instruments is that they can be applied only to individual components which can conveniently be isolated to separate, physically, inductors from capacitors, etc. They are not generally applicable to microwave circuits.

Typical forms of Q-meter embody a variable frequency oscillator, a calibrated low-loss variable capacitor and a valve voltmeter. The principle of operation is to connect the inductor to be tested across the capacitor to produce a tuned circuit and inject into this tuned circuit a constant known voltage at the frequency at which measurement is to be made. The capacitor is then tuned to resonance, as indicated by a maximum voltage reading on the valve voltmeter. The Q-factor is then equal to the ratio of the maximum voltage reading and the voltage injected into the tuned circuit. Since the latter is known, and constant, the valve voltmeter reading can be calibrated to read the Q-factor direct. This is actually the *effective* Q-factor, as measured, and not the *true* Q-factor which is influenced by any stray capacitance the inductor may possess. The effective Q-factor is generally all that is required, although the true Q-factor can be obtained, if necessary, by an extension of the test technique.

Where a commercial Q-meter is not available, various alternative methods of measuring the Q-factor are possible, using elementary equipment. One of these is to employ a radio frequency bridge energized by a suitable signal generator and either a radio receiver or valve voltmeter as the null detector. The bridge is then balanced separately for reactance and resistance, when the Q-factor is calculated as reactance/resistance.

For low frequency work a close approximation of the Q-factor of an inductor can be determined on the basis that the a.c. resistance will be of the same order as the d.c. resistance. It is then only necessary to (i) measure the d.c. resistance of the coil and (ii) apply a known a.c. voltage to the coil and measure the resulting current flowing through it. The Q-factor is then calculated from the following formula:

$$Q = \frac{\sqrt{(E/I)^2 - R^2}}{R}$$

where E = applied a.c. voltage (volt)
I = measured current through coil (amp)
R = d.c. resistance of coil (ohm)

Where higher frequencies are involved the Q-factor can be determined using only a signal generator and a

valve voltmeter, utilizing the circuit shown in Fig. 1. Where the Q-factor of a capacitor is being measured the capacitor assumes the position of C and L2 is a high-Q coil of inductance value calculated so that the resonant frequency of the tuned circuit corresponds to the desired frequency of test. Where an inductor is being tested, this takes the place of L2 and C is an air-spaced capacitor. Inductive coupling is via a rigid one- or two-turn coil L1.

The peak voltage figure is found by tuning the signal generator to resonate the test circuit, noting the corresponding frequency. The signal generator is then detuned, first above and then below the resonant frequency until the voltmeter reading in each case falls to 0·707 of the peak (resonant) voltage, noting the respective frequencies at which this voltmeter reading is reached. The Q-factor is then given by dividing the frequency corresponding to resonance (i.e. maximum voltmeter reading) by the *difference* between the two detuned frequencies (giving 0·707 of the maximum voltage reading).

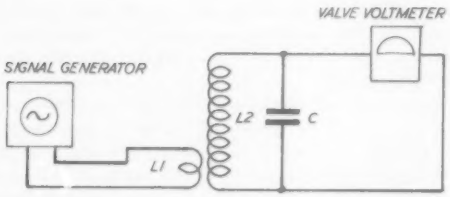


Fig. 1.—Simple circuit for Q-factor measurement using a signal generator and valve voltmeter

This will give a substantially correct value for the Q-factor in the case of a coil, provided the Q of the capacitor is very high. In the case of a capacitor, however, the Q-factor of the coil must be known and the the Q-factor calculated from the test readings corrected accordingly:

$$\text{Q-factor of capacitor} = \frac{\text{I}}{\text{I/Q} - \text{I/Q}_1} = \text{Q}\cdot\text{Q}_1/(\text{Q}_1 - \text{Q})$$

where Q = calculated Q-factor from test readings

Q_1 = Q-factor of coil L2

An alternative method for measuring inductors, which is somewhat preferable, utilizes a similar circuit but in this case the capacitor C is variable and accurately calibrated, and with a maximum capacitance of at least 500 $\mu\mu$f (Fig. 2). This again should be of high-Q type so that the calculated Q for the tuned circuit can be assumed to be the Q of the coil being tested.

The method of test in this case is to set the signal generator to the required test frequency and then tune the circuit to resonance with the variable capacitor, reading the peak voltage on the valve voltmeter. This time, instead of varying the input frequency the variable capacitor is detuned on either side of resonance until the valve voltmeter reading drops to 0·707 of the peak (resonant) value. In all three cases—resonance and the two detuned positions, the corresponding value of the capacity is read from the calibrated scale on the variable capacitor. The Q-factor of the coil is then calculated as the capacity corresponding to peak voltage (resonance) divided by the difference between the two capacity values corresponding to the two detuned positions (0·707 peak voltage).

In both test techniques, it will be appreciated, the valve voltmeter is used only as an indicator and the Q-factor is calculated either on frequency or capacity values. Of the two the second method is more accurate but does demand the use of a precision variable capacitor with a direct reading scale. In both systems, of course, the signal generator output must be stable and constant, with constant coupling (calling for a solidly mounted coupling coil) and a low impedance input lead. The valve voltmeter must have a high impedance R.F. input circuit to minimize loading effects which would otherwise make the tuned circuit non-sensitive or

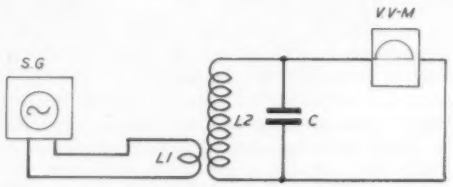


Fig. 2.—More accurate method employing a calibrated variable capacitor, suitable for determining Q-factors of inductors

non-responsive to small variations and lead to inaccuracies in establishing the detuned points. Either are practical methods of Q-factor measurement utilizing a minimum of equipment, where a commercial Q-meter is not available.

Water Purifier

The Mark 6 portable Deminrolit designed and manufactured by The Permutit Company Limited, Permutit House, Gunnersbury Avenue, London W4, can convert up to 12 gal hourly of clean cold water into demineralized water having a conductivity of less than 1·0 reciprocal megohm per centimetre, the quality of water produced by the unit conforming to the purified water standard of the British Pharmacopoeia, 1958.

The Deminrolit is a mixed bed ion exchanger, the ion exchange materials used being Zeo-Karb 225 and De-Acidite FF. It is designed for simple and reliable regeneration on the spot. A conductivity tester is fitted which continuously monitors treated water quality. Constructed as a free-standing unit of robust, non-corrodible construction throughout, and connected by flexible hose the unit is suitable for workshop as well as laboratory conditions.

Activated Oil

A new type of oil, specially formulated to reduce engine wear and improve the performance of cars and commercial vehicles, is announced by the Vigzol Oil Company Limited, Vigzol House, Greenwich, London SE10.

Known as "Activated Vitaflow" it repairs the major deficiency of multi-grade oils—inadequate adhesion to metal surfaces—whilst retaining all their other advantages. Hitherto, the benefits gained by the inherent low viscosity of multi-grade oils have been largely offset by this lack of adhesion during periods of engine idleness.

This new oil is treated with a special additive process that imparts surface adhesion properties to provide an unbroken oil film at all times. This means therefore that the maximum benefit of multi-grade lubrication can now be obtained. An adequate oil film is provided from a cold start and acid corrosion of the engine, formerly prevalent, is now eliminated. Engine wear is thereby reduced and performance improved.

America's Latest Nuclear Reactor

The nuclear reactor for America's latest atomic power plant "went critical" at Rowe, Massachusetts, on August 19. It is the first nuclear-powered electric generating station in the New England section of the United States and will begin producing power this year for the ten utilities which jointly own the facility. The plant has been built for the Yankee Atomic Electric Company.

When the reactor went critical a self-sustaining chain reaction was achieved within the core where the splitting of uranium atoms will provide the heat required to generate steam. The reactor is the largest yet designed and developed by Westinghouse Electric Corporation.

Yankee engineers put the plant into its criticality phase following two weeks of exacting work while 76 uranium oxide fuel assemblies were placed in position individually. Before the fueling operation was started, a 20-ton barrel-like structure was lowered into the pressure vessel to support the 76 fuel assemblies which make up the core, or fuel charge, of the reactor.

The core support is a stainless steel cylinder about 6 ft dia and 18 ft high, which supplies the structural support for the fuel assemblies inside the reactor. The entire support was lowered into the 165 ton pressure vessel with only $\frac{1}{16}$ in. clearance from the sides of the vessel.

In addition to the 76 fuel elements, the core support will help guide 24 control rods which adjust the rate of the fission process in the reactor. This entire assembly makes up the heart of the reactor. Splitting atoms in the reactor will heat high pressure water to a temperature of 529° F. This water will be pumped through a heat exchanger, causing water in a second and completely separate water system to turn into steam.

From this point on, the generating station operation is exactly the same as at a conventional station. The steam drives a turbine which turns a generator to produce electric power.

Westinghouse and Stone & Webster Engineering Corporation have been jointly responsible for the engineering design of the plant. Westinghouse developed the nuclear steam generator and is also supplying the turbine generator and other electrical apparatus. Stone & Webster handled the over-all design, layout and construction of the plant.

Over the past several weeks, Yankee engineers and technicians conducted extensive tests of the hardware portion of the plant in preparing for loading the core.

The Yankee reactor fuel consists of 25 ton of slightly enriched uranium oxide pellets. More than 23,000 stainless steel tubes filled with these pellets have been fabricated into the 76 fuel assemblies, each of which is approximately 8 ft long and 8 in. square. The uranium oxide pellets are twice the length of a pencil eraser. There are almost 3,500,000 of them in the reactor.

The 24 control rods, made of a silver, indium and cadmium alloy, have been arranged in a geometric pattern throughout the reactor core to absorb a portion of the neutrons and thus control the rate of the fission process.

Water in the reactor is kept under a pressure of 2000 psi and will flow through the pressure vessel at a rate of 94,800 gpm.

Combined Thermoelectric and Thermionic Power Generators

A thermionic and thermoelectric generator has been built into a nuclear fuel assembly and inserted into a reactor to produce electricity at the Westinghouse Testing Reactor at Waltz Mill, Pennsylvania, in an experiment to determine the feasibility of such a "dual" generator without consideration of optimum efficiency or high power output.

The test unit produced less than one watt of power, but its operation, according to John W. Simpson, vice president and general manager of the Westinghouse atomic power division, "opened the door to some exciting possibilities", which may include high temperature thermionic-thermoelectric generators for such applications as satellite power supplies, and nuclear powered generating stations with three operational stages—thermionic elements to convert the high temperatures in a reactor into electricity, thermoelectric elements to utilize the more moderate temperatures and conventional generating equipment for lower temperatures.

Pointing out there is a need for such studies, Mr. Simpson said that this new concept will enable industry to take advantage of the high temperatures generated in nuclear reactors. While some fuel elements themselves reach temperatures above 4000°F in the fission process, he explained, nuclear scientists can get only about 600° temperatures out of fuel elements and into the surrounding water where the heat can be put to work. The high temperature advantage is lost because of the temperature drop from the centre of the fuel to the outside.

To capture this energy at its source. Westinghouse scientists built a fuel element with the thermionic generator in its centre and a thermoelectric generator surrounding it. Both methods of converting heat directly to electricity operate on similar principles, but at widely divergent temperatures. A thermionic generator operates at incandescence —about 3500°F.—but will not function efficiently at temperatures below 2700°F. A thermoelectric unit, on the other hand, does not operate at such elevated temperatures, but works well in the temperature range of 600° to 1300°F. By putting the two types of generators in tandem, the heat passing through the thermionic generator flows through the thermoelectric unit. The elements are wired in series to give a combined electrical output over a very wide temperature range.

Eurochemic Company's Service

The object of the Eurochemic Company created in 1957 under the auspices of the O.E.E.C. European Nuclear Energy Agency is to process fuel elements used in the atomic reactors of the participating countries in order to extract the remaining uranium and the plutonium involved in the course of irradiation. This operation is extremely complicated and calls for costly control equipment which makes it prohibitive for many smaller countries.

The Eurochemic plant at Mol in Belgium is highly versatile and can treat fuel elements consisting of metallic uranium or uranium oxide with enrichments up to 5% U^{235}. The fuel elements are shipped from the reactors to the plant in heavily-shielded metal casks. Except where special canning materials are involved, 350 kg of irradiated fuel can be treated in a day.

Another activity of the company is the operation of a research laboratory where all aspects of fuel reprocessing, particularly "wet" reprocessing, can be investigated.

Automatic Press

A press built by Fabrique John A. Chappuis of Switzerland is specially designed for the mass-production of small and medium stampings from coiled metal strip. The horizontal layout facilitates checking, changing of tools and separation of components from waste. The provision of two connecting rods results in a machine of compact size in proportion to tool area and ensures support for the die blocks and ready adjustment for depth. Combined power available from the two connecting rods working simultaneously is 25 to 30 ton, and when working independently 20 tons each.

Stress relieved, high tensile cast iron is used for the framework, and the crankshafts are of hardened and ground nickel-chrome steel. Dovetail slides and cradles are easily adjusted for wear and oblong holes are provided in the top surface of the slide for punch block removal tools. The cradles are located on the base by longitudinal slots; on the 20-ton model they can be fixed in the rear position for normal blocks and in the front position to ensure efficient guiding when very small blocks are used.

Strip feed is by two rollers which grip the material on the faces and not on the edge. Standard capacities are for strip up to 3·15 in. wide on the 20-ton machine, but these can be increased by changing the rollers. Thicknesses may vary according to material from a minimum of 0·004 in. up to a maximum of 0·118 in.

The clamping mechanism, which is adjustable to suit the thickness of strip, can be released and engaged instantaneously, saving time when coils are changed. The feed is set by scale to suit the operation in question.

Accuracy is assured by an automatic stop lever and pilots. The auto-stop lever is fitted to each tool and provides for a safety margin without requiring any excess width of material. An electro-pneumatic safety device can also be fitted if required to control the strip before the impact of the tool by declutching and braking the machine if the position of the strip is not correct; it also operates when the end of the coil is reached.

The ejection levers are actuated by a cam located on the crankshaft and adjustable for angle so that the levers can operate at any point in the machine cycle. In addition to ejecting parts from the dies, they can be made to function as a third connecting rod controlling auxiliary movements, making foldings, light punchings and so on.

Drive to these presses may be through a single-speed motor with three pulleys giving speeds of 80, 100 and 120 rpm or a two-speed motor with coupling gearcase fitted if required to give six speeds ranging from 65 to 200 rpm on the 20-ton machine. Reduction gearing is fitted between the flywheel and crankshaft. Combined clutch and brake action allows the machine to be started or stopped at any position during a revolution. A lubricating pump is provided and is connected to a filter tank in the base of the machine.

Chappuis automatic press

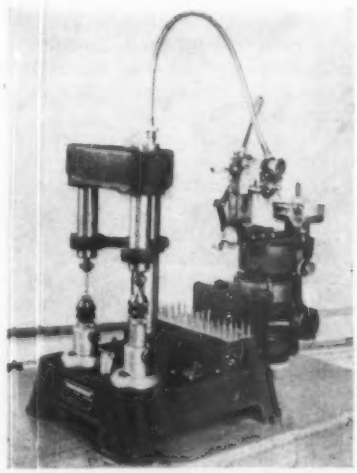
Notable among the accessories available for use with these machines is the new Chappuis press tapping attachment, which eliminates the need for separate threading operations. This device uses normal screw-cutting tools and has a tapping capacity for diameters from about $\frac{3}{32}$ in. to $\frac{1}{4}$ in. to a depth of approximately $\frac{1}{8}$ in.—Stuart Davis Limited, Much Park Street, Coventry.

Lapping Injector Nozzles

A new machine for re-conditioning the seatings of diesel injector nozzles quickly and accurately is being made by Diesel Injection Limited, Ruddington, Notts. This machine, the "Lanzoni" was originally developed and patented by the Lanzoni Company, Mantova, Italy. Diesel Injection Limited has purchased the full world-wide manufacturing rights.

Compact and simple in design, the machine is built for bench mounting and powered by a multi-voltage electric motor of 0.25 hp. It is a two-mandrel machine which will lap and recondition nozzles and also incorporates a high-precision rectifier for the conical needle seatings. Normal manual or mechanized correction is entirely eliminated. Nozzle seatings are lapped by the mandrels which terminate in a conical lapper of specially treated cast iron. The axial hole of the injector nozzle is used as a guide for the mandrel. The conical seating needle may also be super-finished at the exact angle recommended by the nozzle manufacturer by a micro-polished lapping grinder located in the rectifier. A wide range of mandrel sizes means that a lapping mandrel is available for each injector nozzle being treated, and since there are two mandrels working simultaneously, it is possible to carry out the operations very rapidly if necessary on two nozzles at the same time.

At the rear of the machine are two co-axial grinding wheels provided for the successive operations of grinding the cast iron cones of the lapping mandrels and the grinding and consequent high finish of the needle cones. This latter operation is accomplished without the necessity of removing the needle. For re-trueing these two wheels quickly, a diamond in a bracket is fitted. A roller with a flexible drive rotates the needle, the carrier being adjustable to allow grinding at angles varying from 57° to 62°.



Lanzoni machine for reconditioning diezel injector nozzle seatings

Improved Flashcap Lathe

The Herbert No. 2 Flashcap lathe with air-operated turret indexing mechanism, Quadra-chuck, Repeverse and Finistop attachments is specially designed for high production of non-ferrous threaded components, necessitating frequent spindle reversals at high speeds. In recent years, a number of important new features have added to its capabilities.

The air-operated turret-indexing mechanism limits to a minimum the amount of stroke required to index the turret, greatly reducing operational fatigue and idle time.

The No. 2 Quadra-chuck reduces chucking times when machining multiple-end components such as elbows, tees and crosses. Only one chucking is necessary to machine all ends whether of similar or different size or form and machining can be continuous without stopping the spindle. Indexing is effected through a foot-pedal control.

Apart from hand controls to spindle movements, automatic reverse in either direction can be effected by movement of the capstan slide. A push rod mounted over each face of the turret can be set to actuate the reversing motor switch on the headstock either at the beginning or end of each stroke of the turret slide.

Instantaneous reverse for tap or diehead withdrawal, essential particularly when tapping blind holes, is obtained.

To provide for two changes of spindle rotation during one forward and reverse movement of the turret slide, the turret push rod can be fitted with an attachment known as the Repeverse. This attachment is essential when cutting threads from adjacent turret faces or when repetition tapping such as when machining multiple-end components; all ends are tapped between indexing of the turret.

The Finistop attachment, also fitted to the turret push rod, provides rapid stopping of the machine at the end of the cycle of operations. This device not only reduces operational fatigue, by eliminating the hand stop button, but also adds to safety; the spindle is at rest before the operator can proceed to unload the chuck.—Alfred Herbert Limited, Coventry.

Matrix Plunge Grinders

Built at the Brechin works of Coventry Gauge & Tool Company Limited, Matrix Thompson Plunge-Matic grinding machines are completely automatic plunge feed machines designed for fast production grinding of flat or contoured surfaces where the grinding wheel width constantly covers the area to be ground. Sole selling agents in the United Kingdom are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2.

These machines incorporate a triple down feed arrangement, wheel dressing and compensation, rapid return of grinding head to starting position with positioning of table, and demagnetizing of magnetic chuck or release of fixture clamps. The operator loads and unloads the workpiece only. The triple down feed arrangement enables the operator to preselect a variable down feed rate which automatically decreases as the wheel penetrates the workpiece, thus ensuring fast production as it permits the machine to work at the maximum feed rate for the type, size and shape of the stock being ground.

Oscillating wheel heads are available for grinding thin stock of large area. Wheel dressers can be supplied either head mounted or table mounted depending upon the width of the work surface. Multiple wheels can be used mounted on a single arbor for straddle grinding and new electronic "in process" gauging devices can be supplied which will maintain very close tolerances irrespective of wheel or diamond wear. The machines are made in over 20 table sizes with grinding wheels from 14 in. × 1½ in. to 20 in. × 6 in. and wheel spindle motors ranging from 5 to 30 hp.

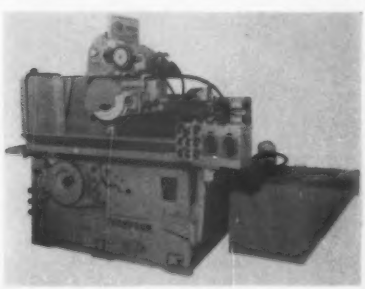
All models incorporate the patented Hydra Cool hydraulic system which has been developed to eliminate the effects of hydraulic system heat, especially where work must be held to close tolerances during long production runs. By eliminating this heat at its source, the Hydra Cool system prevents distortion which would normally occur in the machine, particularly the harmful distortion of the work table. In the Hydra-Cool system there are no external relief valves and the hydraulic oil supply is automatically regulated to suit the machine requirements, never allowing more than the required volume or pressure of oil to be pumped and since this compensation is fully automatic, no excess energy is ever present in the system to be dissipated as heat.

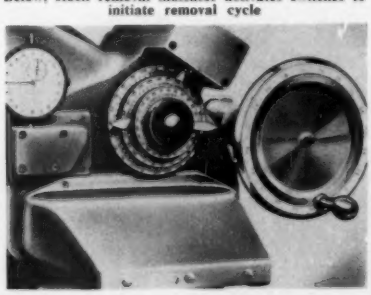
Other direct benefits of the Hydra-Cool system are the elimination of heat damage to the valves, hydraulic seals and other components of the hydraulic system, and a considerable saving in power costs is effected. When the table is stopped the pump stops the supply of hydraulic oil. Due to its cool operation the system will not break down the additive type of hydraulic oils and therefore the formation of sludge is prevented. Furthermore the Hydra-Cool system eliminates the customary warming up period normally required to bring surface grinders up to operating temperature.

The accompanying illustration shows a model B5-12-24 Plunge-Matic machine which has a 12 in. × 24 in. table working surface. Two 14 in. dia × 1 in. wide wheels are mounted for slot grinding, maximum height under the wheels being 16 in. The wheel spindle is driven by a 5 hp 1500 rpm motor.

The automatic cycle includes three separate and variable downfeed rates and automatic wheel dressing and compensation, this being effected

Below left, Matrix Plunge-Matic grinding machine. Below, stock removal indicator activates switches to initiate removal cycle





between the second and third feed ranges. The amount of down feed per table traverse is set by the three pairs of controls at the left of the machine base in conjunction with the dial indicator mounted on the wheel cross slide. The maximum stock removal per pass on each range is 0·004 in. at the maximum table speed of 100 ft/min. Slower table speeds permit higher rates of down-feed. Maximum total stock removal in one cycle is 0·234 in. The stock removal per feed range is determined by the three adjustable arms mounted on the triple dials adjacent to the dial indicator, these arms actuating micro-switches to initiate the following stage of the machine cycle.

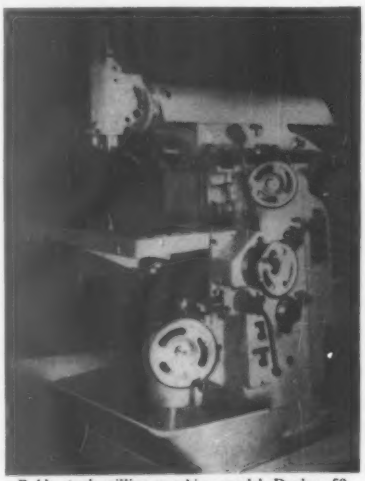
The twin dressing diamonds which are mounted on the wheel head unit are adjustable to remove from the wheels up to 0·008 in. on diameter per dressing, feed of the diamonds being automatic in each dressing. Any number of passes of the diamonds can be made per dressing, this number being set on a dial on the main control panel. Dressing speeds are variable and a stop is provided which can be adjusted to coincide with the minimum wheel diameter acceptable. When this is reached, a warning light on the control panel is illuminated. The second dial on the panel is for selecting the number of cycles between wheel dressings.

When the dressing cycle is completed the wheelhead is automatically fed down to compensate for the amount dressed off the grinding wheels before the third or finish grinding stage commences. This stage is followed by sparking out to final size. The coolant supply is switched off as the wheel head rapid traverses to the start position. Simultaneously, the table traverses to the loading position and stops.

Universal Tool Miller

The Ruhla universal die-sinking and tool milling machine has double sliding rams and will carry out precision milling, boring, drilling and die-sinking operations in vertical, horizontal and angular planes.

The vertical head, which has a vertical movement and is mounted on a horizontal sliding ram, swivels through 360° and has eight spindle speeds, forward and reverse. The horizontal spindle is carried on a sliding ram and has eight spindle speeds. The table has longitudinal



Ruhla tool milling machine model Duplex 59

and vertical movement as well as angular adjustment of 30° each way. The controls are all centralized on the operating side of the machine.—William Watts Limited, Canal Street, Nottingham.

Vertical Grinders

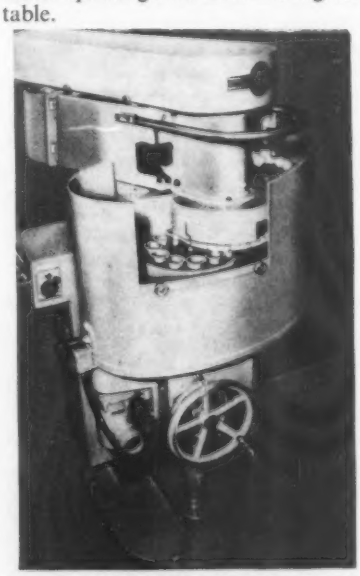
Diskus Werke AG of Frankfurt on Main, West Germany, have recently added to their range of standard and special purpose surface grinding machines two new swivelling head vertical spindle surface grinding machines with rotary tables. These new types are designated DV300R (with hand traverse of wheelhead) and DVH300R (with hydraulic traverse). Sole selling agents in the United Kingdom for the Diskus surface grinding machines are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London NW2.

Both new machines are of rigid and heavy construction, the net weight of the Model DV300R being 1500 lb. The worktable support is accurately guided on long, ground ways integral with the column, vertical traverse being by means of a precision leadscrew and nut. This leadscrew is controlled by a large diameter graduated handwheel, which permits adjustments to less than 0·0002 in. Maximum distance between the magnetic chuck and the grinding wheel is 8 in. on standard machines but machines can be supplied with this capacity increased to 12 in. Standard table diameter is 12 in. but machines with 14 in. dia tables can be supplied to order. The table, which is driven by a two-speed 1 hp motor providing table speeds of 15 and 30 rpm, runs in pre-loaded bearing with automatic adjustment.

The grinding head is mounted on a balanced arm which swivels about an amply dimensioned column on large precision taper roller bearings ensuring smooth and sensitive movement. The heavy, rigid grinding spindle runs in precision anti-friction bearings provided with automatic adjustment to eliminate any play which may occur after a long period of operation. A 12 in. dia segmental grinding wheel is normally fitted but for fine finishes grinding rings are available. Spindle drive is by a wide, flat belt from a totally enclosed 5½ hp motor, both pulleys and belt being guarded efficiently. Provision can be made for swivelling the grinding wheel spindle up to 10° from vertical, permitting rapid and accurate ring grinding.

The Model DVH300R machine is basically similar to the Model DV300R but has hydraulic swivelling motion of the grinding head and arm, traverse being infinitely variable up to a maximum of 80 ft per min. Speed is controlled by a conveniently placed throttle lever which also provides immediate cut-out of the hydraulic movement. The grinding length is controlled by two adjustable trip dogs.

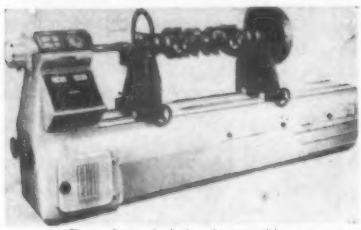
Wet grinding equipment is standard on all machines, a brush ring being fitted around the grinding wheel and a deep, adjustable sheet metal splash guard surrounding the table.



Diskus vertical spindle grinding machine with rotary table

Dynamic Balancing

In the Komposition Type Rava dynamic balancing machine made by Ing. A. Rava, Torino, Italy, the workpiece is supported in rollers which are incorporated in the two pedestals. The pedestals are so constructed that the support rollers are hung by vertical straps and are free to oscillate like a pendulum. Both the pedestals and the rollers are easily adjustable to suit varying components within the capacity of the machine.



Rava dynamic balancing machine

The drive from the headstock to the workpiece is by means of a universal jointed drive shaft in conjunction with adaptors to suit the component. Protective straps are incorporated on each pedestal to prevent a component from being thrown out of the balancing machine.

The instrumentation of this machine is direct indicating and once the first component of a batch has been balanced no further manipulation of the controls is necessary.

An electrical pick-up is located in each pedestal and the motion of the support creates a current which is fed into a four segment commutator rotating with the drive motor at balancing speed. Two opposite segments of the commutator are for the vertical components and the other two segments are for the horizontal components. The two pairs of components are fed separately into two d.c. meters of the zero centre indicating type. Two polar calculators, one for the left plane and one for the right plane are provided above the instrument panel. Each calculator has two knobs, one controls the vertical line and the other the horizontal line. Angle indication is given by a graduated line on the periphery of this calculation and circles drawn from the centre give the unbalance values which can be read instantaneously. When the meter readings are transferred to the calculator the point of intersection of the two lines gives both the amount of unbalance and its angular location. On the main spindle of the machine there is a graduated disc to give the angular references of the unbalance in each plane.

The smaller range of machines have three balancing speeds whilst the larger machines have Ward-Leonard drives giving infinitely variable speeds within the appropriate range. The range of thirty-five standard K machines covers the balancing of components weighing from approximately one ounce to ten ton. It is also possible to supply special capacity machines for specific requirements.

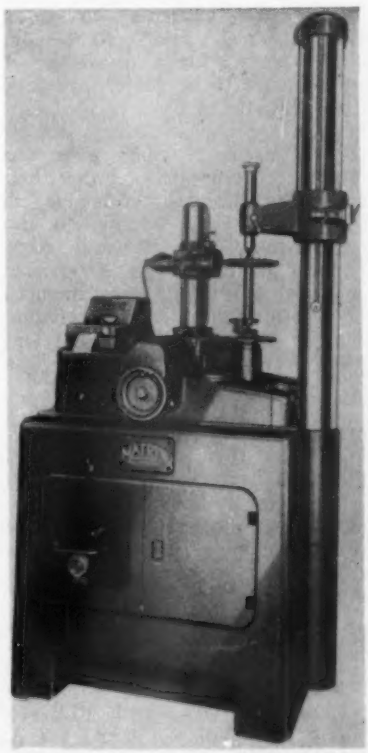
Sole agents for these machines in Great Britain and Eire are Edward G. Herbert Limited, Atlas Works, Levenshulme, Manchester.

Involute Gear Form Measuring

The Matrix involute gear form measuring machine employs the basic principle of generation, using a straight edge operating against a base circle disc, ensuring both accuracy and speed of operation and will measure the form of spur and helical gears up to 12 in. dia. The gears may be mounted on stub mandrels which fit into the work centre bearings, on mandrels between centres, or gears on shafts up to 24 in. between centres can be accommodated. Internal gears can also be measured, the gear being lightly clamped to a work-table and a special measuring stylus used.

The measuring head carrying the stylus is so designed that both flanks of the gear can be measured by turning the stylus head through 180°. For measuring helical gears, the stylus point is mounted in a graduated barrel, so that it can be set to the helix angle of the gear, measurement being made in the axial plane. The machine can be used with either a Taylor, Taylor & Hobson recording unit or a Lowne sensitive indicator, as preferred, the units being interchangeable.

A small variable speed gear box is connected to the measuring slide when the recording unit is used and the ratios are changed to accommodate different depths of tooth in such a way that the length of graph drawn on the recording chart is 3 in. A free wheel in the mechanism ensures that the paper remains stationary when the slide is wound back to its starting position.—Coventry Gauge & Tool Company Limited, Coventry.



Matrix involute gear form measuring machine

Duplex Boring and Turning

The Wyvomatic duplex boring and turning machine has been produced for the simultaneous machining of parts turned, faced or bored. It is a production machine, simply arranged to facilitate setting up, yet capable of high output. Spindles are robust and mounted on high precision bearings; speeds up to 3,500 rpm are available as standard. The table stroke is 9 in. with facing heads 6 in. dia.

When arranged for hydraulic copy turning the machine can produce complex parts without any special tooling. The sequence is automatic and the machine is so arranged that the movements may be operated independently if desired. No cams are required.—Wyvern Machines Limited, Percy Road, Leicester.

books

Introduction to the Gas Turbine. By D. G. Shepherd, London, 1960; Constable & Co. Limited. 45/- net (by post 46/4). 300 pp. $5\frac{3}{4} \times 9\frac{1}{2}$ in.

Although designated as the second edition of a work first published in 1949 this is a completely rewritten text and can in fact be regarded as a new book. The author states that in the intervening years he has come to believe that a more basic approach to his subject would be of greater value and to this end he has concentrated more on broad principles with correspondingly less detail.

A knowledge of elementary thermodynamics and fluid flow has been assumed on the part of the reader so that only relevant topics need be gone into fully. After a short introductory chapter there follow two chapters on cycle analysis—ideal and actual—the author considering a knowledge of performance to be more important than design detail. Cycle performance has been approached through looking for the optimum cycle, given the recognized components, rather than by taking the gas turbine in its simple form and adding on the components. The principal components are dealt with in separate chapters, again with the emphasis on performance. A concluding chapter deals with the present and future applications of the gas turbine.

The use of the gas turbine as a practical heat engine goes back little more than twenty years and though it has made rapid advances it has, as the author says, reached no more than "adolescence". This book is a useful introduction to a prime mover which has great potentialities in numerous fields.

Heat Treatment of Metals. By P. S. Houghton. Brighton, 1960; The Machinery Publishing Company Limited. 2 vols., each 18/6 (by post 19/4). Vol. 1, 156 pp., Vol. 2, 184 pp. $5\frac{1}{2} \times 8\frac{3}{4}$ in.

This two-volume work aims at providing in simple terms a full coverage of the heat treatment of metals for manufacturing processes and services. The author, who has based the book on his own training and experience which includes some years as a lecturer in production engineering, has had in mind the requirements of the large number of people in engineering and allied industries for whom some knowledge of the heat treatment process is necessary. Accordingly his approach is simple and basic.

The various aspects of the subject are dealt with in the following sequence: types of heat treatment; the process applied to non-ferrous alloys; the iron-carbon diagram; grain size; the heat treatment of steel and cast iron; tempering and case hardening; hardenability; isothermal transformation; the choice and treatment of tool steels; heating and cooling; types of furnace in use; and the design of components for heat treatment.

The book is written in a clear and straightforward style and the layman will follow it with ease. It is well illustrated with line drawings and photographs and there are many tables—including a number giving data on B.S. and S.A.E. steels and alloys.

Technical Illustration. By T. A. Thomas. London, 1960; McGraw-Hill Book Company Inc. 50/6 (by post 52/-). 150 pp. $8\frac{1}{2} \times 11\frac{1}{2}$ in.

This is the work of a teacher of technical illustration in a Californian college who has also been employed as a technical illustrator by a number of leading American companies, and it has the polish and freshness of approach characteristic of many American instructional books.

It is concerned solely with technical illustration and requires from its readers a knowledge of fundamental draughtsmanship—orthographic projection, lettering, geometric construction, etc. The text falls roughly into three parts. The first discusses basic technical drawing, freehand technical drawing, the use of ellipse and hexagon templates, drawing simple shapes and objects—sphere, screws, wheels, etc. The second part covers the principal types of projection drawing, axonometric, isometric, dimetric and trimetric, and perspective drawing. There is also a short chapter on shading techniques and retouching photographs. The final part deals with ink and drawing equipment. In addition there is an appendix containing the section on pictorial drawing from the American Drafting Standard Manual, and more than forty pages of examples ranging from the simple to the complicated, many taken directly from industry. Needless to say, the major portion of the book is made up of illustrations, all of them brilliantly drawn.

In the preface the author states that he intends the book for use as a classroom textbook, for home study, and for reference. But as such a wide field is covered, thus limiting the amount devoted to any one aspect of the subject, it will probably prove of lasting value as a reference work.

Workshop Engineering Practice. Volume 2; Lathe Work. By H. G. Rider. London, 1960; Iliffe and Sons Limited. 9/6 net (by post 10/1). 138 pp. $5\frac{1}{4} \times 8\frac{1}{4}$ in.

This is an elementary work intended for students at secondary modern and junior technical schools or those studying for the craft examinations of the City and Guilds of London Institute. It is written in very simple, non-technical language and describes in a detailed manner the most fundamental aspects of the subject. To clarify the text still further there are more than 340 excellent drawings. Three chapters are devoted to practical exercises in turning between centres, turning a bush from a bar, and the use of chucks and mandrel.

Ergonomics of Automation.—The term *ergonomics* has come into use to cover the collaboration between engineering, experimental psychology, anatomy and physiology in the task of "fitting the job to the man". The Department of Scientific and Industrial Research has now published in its Problems of Progress in Industry series "Ergonomics of Automation" by A. T. Welford (H.M.S.O. 3/6 net) which surveys in broad outline those aspects of ergonomics likely to bear on questions of automatic equipment design and on the human problems likely to arise in automation work.

Fuel Efficiency.—The activities of the National Industrial Fuel Efficiency Service, 7 Grosvenor Street, London, W1, in a wide range of industries are surveyed in the

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158 Temple Chambers, Temple Avenue, London, E.C.4

recently published annual report. This also shows a substantial increase in earnings over the previous year, a demand for the advice of the service's engineers outside the United Kingdom and rising bookings for further work. The chairman states that, as a result of the recognition by industry of the ability of N.I.F.E.S. engineers, the board can express great confidence in the future.

Welding Research.—Welding, today, frequently involves using new materials and working to standards which were inconceivable only a few years ago. The net result is that, apart from maintaining a large 'minimum' programme of work, the British Welding Research Association, Abington Hall, Cambridge, is increasingly being called upon to meet specific problems in design, in selection of welding conditions and in the choice of materials. This is particularly evident from the 15th annual report of the association which, in addition to outlining its research programme, deals with the increasing number of problems posed by members.

Structural Materials: Line Standards.—Two new monographs have been published by the United States National Bureau of Standards. "Mechanical Properties of Structural Materials at Low Temperatures—A Compilation from the Literature", by R. M. McClintock and H. P. Gibbons (price one dollar, fifty cents), has been issued to help fill the need for a compilation of useful design figures. It includes tensile strength, yield strength, tensile elongation, and impact energy of about 200 materials, metallic and non-metallic, given graphically as functions of temperature between 4 to 300° K. "Calibration of Line Standards of Length and Measuring Tapes at the National Bureau of Standards," by L. V. Judson (fifteen cents), is intended as a guide for anyone contemplating the submission of line standards of length and measuring tapes to the bureau for calibration and includes an outline of the calibration methods used at the National Bureau of Standards. The monographs can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. and remittances should be in U.S. currency and include an additional quarter of the price to cover postage.

Locomotive Tests.—Performance and efficiency tests carried out on a B.T.H./Paxman Type 1800 hp B-B diesel electric locomotive are the subject of British Railways Bulletin No. 12, price 10/- net, published by the British Transport Commission, Room 268, 222 Marylebone Road, London NW1. The object of the tests was to determine performance and related fuel consumption, to provide data for calculating train schedules, and to demonstrate the distinctive features of the electrical transmission system.

Structural Steelwork Design.—British Constructional Steelwork Association Publication No. 13/1960, "Examples of Structural Steel Design to conform with the requirements of B.S. 449/1959", by Lewis E. Kent and E. G. Lovejoy, is a revised edition of B.C.S.A. brochures Nos. 1, 2 and 4, completely rewritten to accord with the requirements of B.S. 449/1959, "The Use of Structural Steel in Building". The complete analysis and design is given for two single storey sheds with pitched truss roofs of 50 ft span. A single bay structure and a three bay structure are dealt with in detail and all elements of the structure are included, from purlins to holding down bolts, attention being drawn to the appropriate clauses in B.S. 449. The brochure is available from the association at 94/98 Petty France, London SW1, price 3/6.

Diesel Oil.—A paper on the thermal behaviour of diesel engine oils presented to the Société des Ingénieurs de l'Automobile has now been published. The authors are Jean MacNab and Alain de Goldlin, both of Antar Petroles de l'Atlantique S.A., who are principally concerned with a coking bench developed at the Antar laboratories which shows a rate of aging similar to that observed in a diesel engine. The address of the Antar company, from whom the publication can be obtained, is: 4 Rue Léon Jost, Paris 17E.

New Standards

Standard symbols.—To reflect the considerable progress in standard notation that has been achieved during recent years it has been decided to make a comprehensive revision of Part 1, B.S. 1991, "Letter symbols, signs and abbreviations". Meanwhile an amendment has been issued (PD 3920), available free of charge from the B.S.I. to all those holding copies of B.S. 1991.

The following points of particular interest will be found among the revisions made in the amendment: in order to distinquish between the pound as a unit of mass and the weight of a pound under standard gravity as a unit of force, distinctive abbreviations are recommended, "lb" for pound mass and "lbf" for pound-force, and, "kg" for kilogramme mass and "kgf" for kilogramme-force, etc.; it has been decided to maintain more rigorously than hitherto the general principle that symbolic abbreviations for units should not carry a full stop as part of an abbreviation, and in future all the abbreviations for metric and British units in B.S. 1991 will follow this principle, e.g., the recommended abbreviations for horse-power and British thermal unit should be written "hp" and "Btu", without full stops.

Concrete poles for electrical transmission and traction systems (B.S. 607: 1960). Price 4/6.

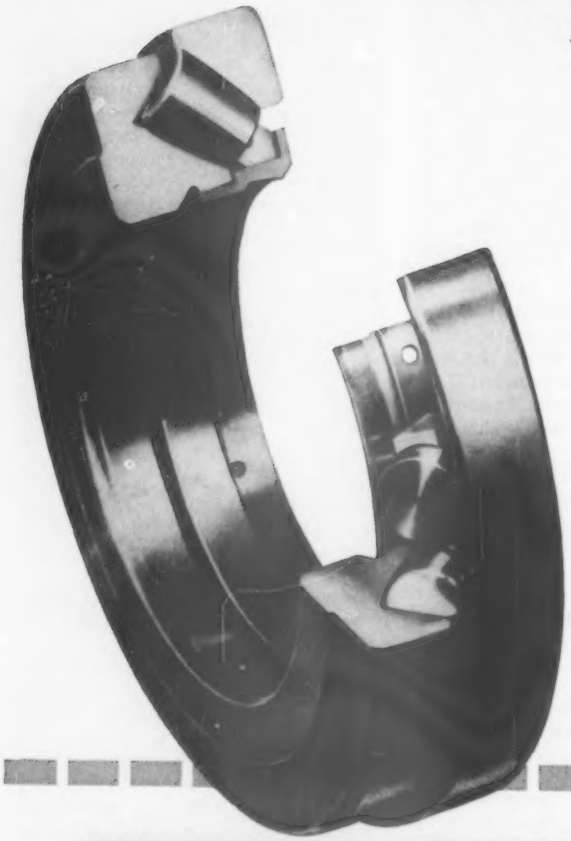
This specification has been revised and its scope extended to cover requirements for prestressed poles and prestressed poles that may be exposed to impact. It provides design requirements and test procedures for reinforced concrete and prestressed concrete poles suitable for supporting electrical transmission and traction lines, including supports for telegraph and telephone lines—but not lighting columns. Recommendations for the provision of holes and particulars of markings are also given.

Guaranteed minimum reckoners for the building and civil engineering industries (B.S. 1151: Part 2). Price 5/-.

Designed by and for the building and civil engineering industries, the contents of this standard reflect requirements for the changes in working weeks which now operate in these industries. It gives the formula for calculating the appropriate 'guaranteed minimum' due to an operative when the number of working hours available to him is less than the normal hours laid down in the Working Rule Agreement. In addition, there are four tables of ready reckoners—two for each industry.

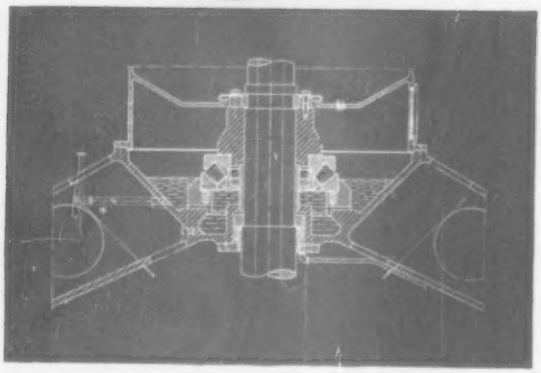
British Standards Institution, 2 Park Street London W1.

Only SKF *can offer such a wide selection of British made bearings*

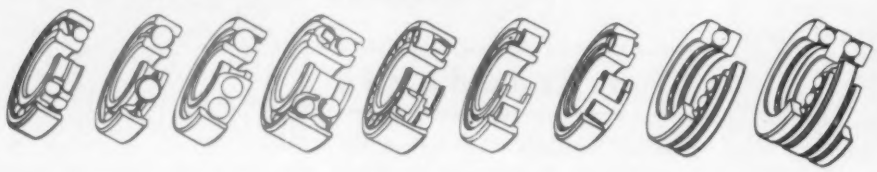


The spherical roller thrust bearing has one row of obliquely disposed rollers guided by a high flange on the shaft washer and running on a sphered track on the housing washer. It combines very high carrying capacity with complete self-alignment. The surface of the roller end next to the guiding flange is so formed that the rollers are always separated from the flange by an oil film when under load. The bearing can therefore be used at relatively high speeds, even if the load is very heavy. Unlike other thrust bearings, it can also carry radial loads.

Technical advice on the application of spherical roller thrust bearings, as well as other types of rolling bearings is always readily available from Luton or from any one of the twenty Skefko Branch Offices in the British Isles.



Support bearing for vertical electric generator



THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

GI81

BUSINESS & PROFESSIONAL

Personal

POLLARD BALL AND ROLLER BEARING Company Limited announce the appointment of **Mr. N. A. Slater** as commercial manager, based at the Ferrybridge works of the Group.

EIMCO (GREAT BRITAIN) LIMITED, Team Valley, Gateshead 11, manufacturers of rotary vacuum and pressure filters and other equipment for the chemical and process industries, have made the following changes in their filter division: **Mr. Clifford J. Smith** takes over as manager from **Mr. Charles E. Silverblatt** who will remain until early next year in a consultative capacity before returning to the United States of America. **Mr. Neville A. Satchwell,** previously chief draughtsman, has been appointed project manager to co-ordinate the activities of the filter division under Mr. Smith. **Mr. Edward W. Laird** takes over from Mr. Satchwell as chief draughtsman.

Mr. D. L. Bonnell has been appointed sales representative for The Hymatic Engineering Company Limited of Redditch, Worcs., for South Wales, Gloucestershire and Somerset. He will be responsible for the Hymatic hydrovane compressor division.

Mr. Clifford E. Passmore has been appointed field sales manager for the Midland Region of Griffin & George (Sales) Limited.

THE CO-OPERATIVE WHOLESALE SOCIETY announce that **Mr. Oswin Castick, A.M.I.Mech.E.,** has been appointed chief engineer, Manchester, in succession to **Mr. G. K. Medlock** recently elected a director of the C.W.S. Mr. Castick joined the staff of the C.W.S. Engineering Department in 1938.

THE following appointments have been made by the research and development division of Cawkell Research & Electronics Limited. **Mr. R. D. Stafford, A.M.I.E.E.,** chief engineer, industrial division; **Mr. R. Reeves, A.M.I.E.E.,** chief engineer, special products division; **Mr. D. Parker, B.Sc.,** senior engineer, special services. Mr. Stafford is also a director of the company.

WOLF ELECTRIC TOOLS LIMITED London, announce the appointment of **Mr. D. F. Kershaw** as general manager of their Canadian branch at 93 Advance Road, Toronto 18, Ontario. Mr. Kershaw has lived in Ontario for the past six years, occupying a position of responsibility in the machine tool industry.

Mr. N. E. F. Hitchcock, B.Sc., F.Inst.Pet., has been appointed laboratory manager of the Castrol Group's main research establishment at Hayes, Middlesex, in succession to the late **Mr. P. W. L. Gossling.** He will hold this office in addition to that of group development chemist, a position he has occupied for the last nine years.

Mr. Alan S. Gill has retired from the board of George Cohen Sons and Company Limited on attaining the age of 65, and will practise as an industrial consultant.

FOLLOWING the appointment of **Mr. Stanley Castledine** as general manager of the engineering departments of The Butterley Company Limited, Ripley, Derbyshire, **Mr. K. S. Martin** has been appointed deputy general manager of the engineering departments. Mr. Martin was previously assistant civil engineer of the London Midland Region of the British Transport Commission. **Mr. Ian Lees,** who has worked for The Butterley Company for the past nine years, has been appointed from assistant manager of the constructional section of Butterley Ironworks to manager of the section.

Mr. C. G. T. Hyslop retired from the board of Birfield Limited on October 19 upon reaching his 70th birthday. He continues as chairman of three Birfield Group companies, The Phosphor Bronze Company Limited, Kent Alloys Limited, and R. Jones & Co. Limited.

Mr. Tom Hannaby, M.S.M.A., has been appointed general sales manager of Mine Safety Appliances Company Limited, Glasgow—manufacturers of a wide range of mining and industrial safety equipment.

FLETCHER MILLER LIMITED, manufacturers of cutting and lubricating oils, have appointed **Mr. Bernard Fraser, A.M.I.Mech.E., A.M.I.Prod.E.,** as applications engineer at their head office and works, at Hyde, Cheshire.

Mr. J. D. Dale-Lace, A.M.I.E.E., D.F.H., has been appointed sales manager of Radio Components and Special Products Department, A.E.I. radio and electronic components division.

Mr. N. J. Fuller has been appointed assistant sales manager of Goodyear Pumps Limited. **Mr. J. C. Reid** who joined Goodyear from Holman Brothers Limited its parent company in 1958, has been appointed representative in Scotland and will operate from Goodyear's offices at 20–26 Ashton Lane, Glasgow, W2.

Mr. Claud Laurence has resigned from the board of Laurence, Scott & Electromotors Limited, after thirty-seven years' service. His son **Mr. J. A. Laurence** has been appointed to the vacancy thus created.

THE PLESSEY COMPANY LIMITED announces the appointment of **Mr. N. L. Lupton, M.A., A.F.R.Ae.S., A.S.M.A.,** as contracts manager of the Electronics and Equipment Group.

Mr. W. T. Flower, sales director of Bailey Meters & Controls Limited, has been appointed deputy managing director.

Mr. A. E. Richards has been appointed managing director of Universal Matthey Products Limited, the joint subsidiary company of Universal Oil Products Company and Johnson, Matthey & Co. Limited formed in 1953 to meet the needs of the petroleum and petrochemical industries for catalysts.

Mr. E. Humphrey Browne, C.B.E., deputy chairman of the National Coal Board has been appointed a director of the National Industrial Fuel Efficiency Service.

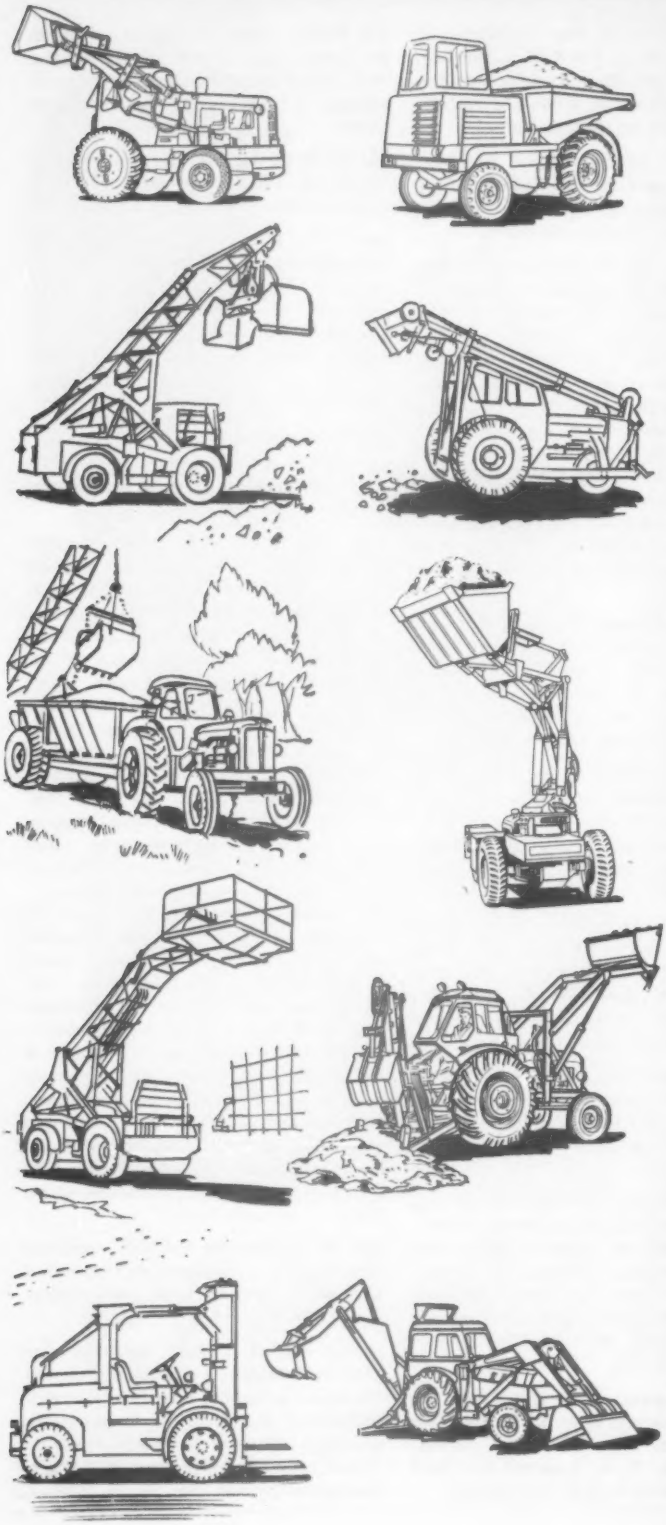
THE UNITED STEEL COMPANIES LIMITED announce that following the appointment by Tube Investments Limited of **Mr. G. E. D. Halahan,** at present director and general works manager of Steel, Peech and Tozer, as director and general manager of the Round Oak Steelworks Limited, from December 1, 1960, they have appointed **Mr. H. Darnell,** director and general works manager of Workington Iron and Steel Company, as director and general works manager at Steel, Peech and Tozer. **Mr. N. D. Macdonald,** at present works manager (iron) at Appleby-Frodingham Steel Company, is to be general works manager of Workington Iron and Steel Company.

Mr. Derek L. Lee has been appointed managing director of Unisteel Structural (Pty) Limited, of Cape Town, South Africa. **Mr. H. M. Henderson,** who relinquishes the position of managing director at the end of October in order to become director and general manager of Workington Iron and Steel Company, remains a director of the South African company. **Mr. K. Paterson,** director and general manager of United Steel Structural Company Limited, Scunthorpe, has been appointed a director of Unisteel Structural (Pty).

Mr. H. V. Rowlands has been appointed sales director for Burtonwood Engineering Company Limited, of Warrington, Lancashire.

DOWTY GROUP LIMITED announce that **Mr. Lionel Harper,** a director of Coventry Precision Limited has been appointed vice-chairman of the board. Mr. Harper is also managing director of Dowty Hydraulic Units Limited and a director of Designex (Coventry) Limited. **Mr. E. S. Gibbons,**

EXPERIENCED OPERATORS INSIST ON



FORDSON POWER

Men who have kept to the tightest schedules in the toughest conditions; men who have manned machines working round the clock, seven days a week; these are the men who know from experience that for proved reliability Fordson Power is unequalled. Add to reliability all the other Fordson advantages of high output, low costs, unrivalled service and spare parts organisation, and almost unlimited choice of build-ups in the 30-40 and 40-50 b.h.p. classes. That's why more Fordson power units than any other are used in industrial equipment. Write for detailed specifications.

WISE BUYERS INSIST ON FORDSON POWER

INDUSTRIAL SALES DEPARTMENT · TRACTOR DIVISION
FORD MOTOR COMPANY LIMITED · DAGENHAM ESSEX

managing director of Designex Limited, has been appointed to the board of Coventry Precision Limited.

FOLLOWING upon the death of Mr. A. E. Hollings, managing director of Dowding & Mills Limited, **Mr. G. A. Onion** has been appointed to the board. Mr. Onion will be director in charge of the Birmingham Works and **Mr. P. L. Hollings** will continue as director controlling the London and Southampton Works. **Mr. W. L. Henderson** is promoted to manager of London Works with **Mr. P. A. Chambers** as assistant and, **Mr. H. Westwood** the manager of Birmingham Works with **Mr. F. J. Gardiner** as assistant.

Mr. W. D. Cowie has joined Stanley Howard Limited, Birmingham, as technical representative for their complete range of machine tools for the London area.

Mr. A. Hutchinson, Mr. R. F. Horton, Mr. I. G. Buchan, have been appointed to the board of Samuel Osborn & Co. Limited and **Mr. J. Williams and Mr. V. P. Giles** become local directors. **Mr. F. May** becomes chairman of the subsidiary board. **Mr. R. Thompson** has been appointed to the board of Burys & Co. Limited; **Mr. A. C. Dennis** to the board of Osborn Foundry & Engineering Company Limited, and **Mr. F. A. Kirk** to the board of Titanic Steel Company Limited.

FORMERLY a staff member of Production-Engineering Limited, management and industrial consultants, **Mr. Gordon Ellis** has been appointed managing director of Farrar Boiler Works Limited, Newark-on-Trent.

J. BLAKEBOROUGH & SONS LIMITED, valve specialists, Brighouse, announce the appointment of **Mr. W. L. Gibson, B.Sc.,** recently returned from occupying an executive position with the Hydro-Electric Power Commission of Ontario, to be their chief engineer. **Mr. C. D. Blakeborough, B.Sc.,** will continue to be the manager of their nuclear and steam division, and becomes the chief assistant to their sales director, **Mr. W. E. Ashley.**

Mr. J. F. Parker (chairman), **Mr. G. St. J. Strutt, C.B.E.,** and **Mr. E. S. Parker** have retired from the board of British Rolling Mills Limited. Mr. J. F. Parker was a founder director of the company, Mr. Strutt served as a director for 40 years and Mr. E. S. Parker has been connected with the company for nearly 50 years. **Mr. R. Ll. Lloyd** has been appointed chairman.

Mr. D. A. Ogilvie, M.A., A.M.I.Mech.E., a drawing office manager with the parent company, Baker Perkins Limited of Peterborough, has been appointed a director of Baker Perkins (Exports) Limited, Swallow Street, London W1.

NEW appointments announced by I.T.D. Limited, are as follows: **Mr. P. O. Richards** to be southern area branch manager; **Mr. K. R. Townsend** to be northern area branch manager.

Mr. A. M. Hinde has been appointed Midland division manager, Power Petroleum Company in succession to **Mr. E. St. C. Forbes,** who retired on September 30, 1960, for health reasons, after more than 32 years' service with the company.

THE CONSOLIDATED PNEUMATIC TOOL Company Limited of 232, Dawes Road, London SW6, have announced the appointment of **Mr. Jack Gibson, B.A., LL.B.,** as managing director of their South African subsidiary, The Consolidated Pneumatic Tool Company S.A. (Pty), Limited Johannesburg.

Mr. J. Faulds is now the technical sales representative for Kelvin Hughes products in North and North Eastern England. The area covered includes the Counties of Northumberland, Durham, Cumberland, Westmorland, North Riding of Yorkshire and Barrow-in-Furness.

Mr. J. S. Brough, M.I.Chem.E., M.I.Mech.E., M.Inst.F., F.Inst.Pet., has been appointed to the board of directors of Mono Pumps Limited as assistant managing director.

CREATORS LIMITED of Woking, manufacturers of injection mouldings, extrusions and fabrications, announce new appointments in their technical sales organization. **Mr. R. Martin** joins the company as technical sales manager with **Mr. J. Buchanan** representing the motor and **Mr. H. A. Wheatley,** the furniture industries.

Addresses

THE Birmingham office of the Export Credits Guarantee Department (the Government Department insuring exporters against the risks of not being paid) will move this week-end to new premises in Chamber of Commerce House, Harborne Road.

GRIFFIN & GEORGE Group of Companies, Ealing Road, Alperton, Middlesex, manufacturers of scientific equipment, have opened their new northern sales and service centre at Ledson Road, Wythenshawe, Manchester 23.

OLDHAM & SON LIMITED, the Denton, Manchester, battery and electrical equipment manufacturers, have changed the address of their Birmingham office and depot to Norwood Road, Bordesley Green, Birmingham 9. The telephone number remains unchanged, Birmingham Victoria 1994.

VOKES LIMITED, filtration and silencing engineers, has changed its name to Vokes Group Limited, and a new subsidiary company, Vokes Limited, has been incorporated to take over the business and trading of Vokes Limited as previously.

SRO BEARING COMPANY (SALES) LIMITED, the recently formed British sales organization of SRO Ball Bearing Works Schmid-Roost Limited, have now opened premises at 164 Camberwell Road, London SE5. (Telephone: RODney 6222.)

THE headquarters of the Birfield Group of Companies are now located at their new London offices at 20 Hill Street, London W1. The telegraphic address becomes Beltistos, Audley, London, but the telephone number is unchanged at Grosvenor 7090.

NEGRETTI & ZAMBRA LIMITED have opened a new branch at 38 Dean Street, Newcastle upon Tyne.

THE telephone number of the Middlesbrough branch of British Insulated Callender's Cables Limited has been altered to Middlesbrough 43256/7/8.

THE telephone number of Turner Brothers Asbestos Company Limited, 14 Finsbury Circus, London EC2, has been changed to London Wall 5471 (6 lines).

THE Cardiff office of George Ellison Limited has been transferred to new premises at 306 Western Avenue, Llandaff, Cardiff. Telephone: Cardiff 72701.

THE recently formed AEI/Davy-United Steelworks Automation Unit has its headquarters at Mill Road, Rugby, with representatives both at Davy-United Limited, Sheffield and at AEI Heavy Plant Division, Rugby.

MALCOLM & ALLAN (LONDON) LIMITED and Cable Jointers Limited have amalgamated under one management and are now operating from 229 High Street, Acton, London W3, telephone Acorn 7811. Both are companies in the Metal Industries Group.

THE Research and Development Division of Cawkell Research & Electronics Limited is now housed at 99 Uxbridge Road, Ealing, London W5.

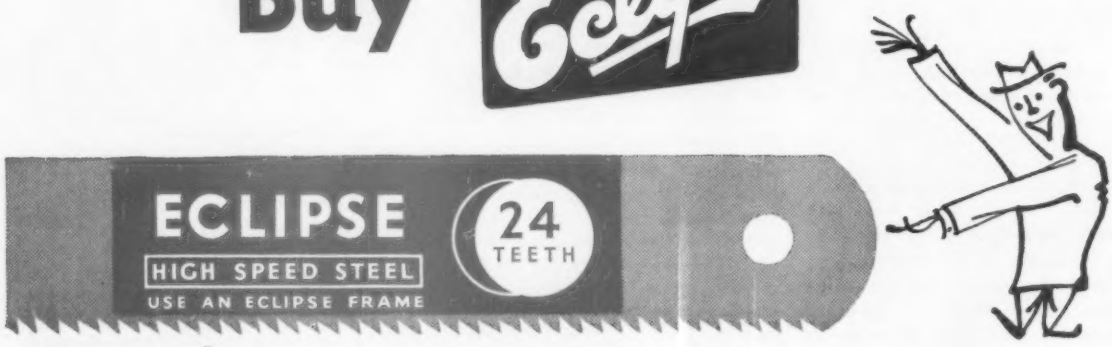
GEORGE COHEN SONS AND COMPANY Limited has now registered '600' as its Trade Mark. Most of its associates in The George Cohen 600 Group will be registered users of the Mark.

Film News

The Brook, a 16 mm. colour sound film, has been produced by Brook Motors Limited of Huddersfield. *The Brook* is the story of a Yorkshire river—and of some of the industries it passes as it is traced from a moorland stream to the sea. Running time of the film is 28 minutes and is available on free loan on application to the firm's publicity department at Empress Works, Huddersfield.

more & more people

buy Eclipse



'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

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Contracts and Work in Progress

HONEYWELL CONTROLS LIMITED, Greenford, Middlesex.—Contract for instrumentation for the automatic control of a Russian sugar factory placed by the main contractors for the factory, Vickers and Bookers Limited, London and Scotland. Value of the equipment, most of which will be made at Newhouse, Scotland, is £30,000.

FERRANTI LIMITED.—Order for an Orion data processing system for Beecham Group Limited, manufacturers of soft drinks, toilet and pharmaceutical products, etc. The installation, with its associated input, output and magnetic-tape data storage equipment, will cost approximately £300,000.

ENGLISH ELECTRIC COMPANY LIMITED.—Repeat order for a 200,000 kilowatt steam turbo-alternator for the Electricity Supply Commission of New South Wales power station at Vales Point, making three in all. With auxiliary plant manufactured in Australia the contract is worth £A2¼ million.

THE SOUTH OF SCOTLAND ELECTRICITY Board has placed an order valued at approximately £1¼ million with Scottish Cables Limited, a member of the BICC Group.

WILLIAM BOBY & CO. LIMITED, Rickmansworth.—Contract for a lime-soda plant at W. D. & H. O. Wills' No. 4 factory, Bristol, valued at about £2,600.

£4500 contract to modernize and augment existing Boby water treatment plant at Monsanto Chemicals, Ruabon.

Contract for pressure filters and chemical dosing plant for The Distillers Company at their Windygates (Fife) Distillery.

Contract from the English Electric Company Limited value £25,000 for effluent treatment plant at Hinckley Point nuclear power station.

AEI-BIRLEC LIMITED (Tyburn Road, Birmingham 24).—A battery of four unusual coil annealing furnaces which use an oil-fired radiant tube heating system, has been ordered by James Booth Aluminium Limited for their Kitts Green Works, Birmingham, as part of James Booth's £5 million re-equipment and expansion programme which is scheduled for completion next year. The equipment will cost well over £100,000.

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—*Instrumentation Division*: An order, value £50,000, has been received from a London confirming house for two MS7 spark-source mass spectrometers for Russia. The spectrometers will be manufactured at the A.E.I. Trafford Park Works and will be delivered to V/O Mashpriborintorg U.S.S.R.

Orders for MS7 spectromers have also been received by A.E.I. from the U.S.A., Germany, France, Switzerland and in this country from the National Physical Laboratory, the Services Electronic Research Laboratory and the U.K.A.E.A. *Heavy Plant Division:* Manufacturing instructions for mine-winders worth more than £230,000 from the National Coal Board and from the Union Corporation of South Africa. *Switchgear Division:* Recent orders from the C.E.G.B. include switchgear for extensions to the existing stations at Aberthaw and Swansea North. *Transformer Division:* Order from the Central Electricity Generating Board for four 75,000-KVA 3-phase transformers for Templeborough substation.

ASSOCIATED ELECTRICAL INDUSTRIES (Canada) Limited.—Order from Bowaters Engineering & Development Inc., of Calhoun, Tennessee, on behalf of the Tasman Pulp and Paper Company Limited, Kawerau, New Zealand, for seven single-reduction gearboxes and spares, worth £70,000, for use in a wood-pulp mill in New Zealand. The gearboxes, each of which will transmit 6,325 h.p., will be manufactured at Rugby by A.E.I. Heavy Plant Division.

FIELDING & PLATT LIMITED.—Order received through Burton Griffiths for a 50 metre ton counterblow hammer designed by Beche & Grohs, of Germany, for the Sheffield firm of Ambrose Shardlow & Co. Limited, crankshaft forgemasters.

CRAVEN BROTHERS (Manchester) LIMITED.—Order from James Booth Aluminium Limited for a £41,000 extra heavy duty roll grinding machine for installation in their Kitts Green Works, Birmingham.

DISTINGTON ENGINEERING COMPANY Limited, Workington, a branch of The United Steel Companies Limited, in conjunction with their associates Concast A.G., Zurich.—Order for a vertical continuous casting plant for billets on behalf of Canara Workshops Limited, Mangalore, India.

Order from Richard Thomas and Baldwins Limited, a vertical continuous casting plant for the production of large slabs for installation in their Panteg Works.

BURTONWOOD ENGINEERING COMPANY Limited, Warrington, Lancs.—Orders totalling £126,000 have been received in the last three weeks, following a recent tour of Russia and Western Europe by Mr. H. V. Rowlands, newly appointed sales director.

BRITISH RAILWAYS, SCOTTISH REGION.—The following contracts have been placed: Ellis & MacDougall, Glasgow, two goods lifts for Perth station. Concrete (Scotland) Limited, Falkirk. Precast concrete units for nine bridges.

Business Developments

Agents and distributors

U.S. INDUSTRIES INC. (GREAT BRITAIN) Limited are now acting as European representatives for the Frick Company, Sawmill Division.

IONIC ELECTROSTATIC CORPORATION of New Jersey, U.S.A., have appointed H. R. Noble Limited, 236 North Circular Road, Palmers Green, London N13, England, as exclusive Great Britain distributors.

WICKMAN MINING DIVISION, Bottrill Street, Nuneaton, have now assumed sole agency in the United Kingdom for the range of mining and construction equipment built by the Gardner-Denver Company, Illinois, U.S.A.

WICKMAN LIMITED in agreement with Ateliers des Charmilles, S.A., Geneva, have assumed sole selling agency in the United Kingdom for the Elero 1a Model D.1 Electro-Erosion Machine.

THE KINGSLAND ENGINEERING COMPANY LIMITED, 25-37, Hackney Road, London E2, have taken over representation in the Southern half of England for A. J. Morgan & Sons (Lye) Limited, manufacturers of hand and powered guillotines, bending rolls, etc.

A New S.I.M.A. Guide

THE SCIENTIFIC INSTRUMENT Manufacturers' Association of Gt. Britain, 20 Queen Anne St. W1, has published a booklet "Careers in the Scientific Instrument Industry", which gives a brief well-illustrated summary of what a new entrant into the industry can expect to find and what his work and training may be like. The booklet of 20 pages has 42 photographs showing both many types of scientific instruments in action and skilled craftsmen constructing them and also assisting apprentices. Two pages contain a very useful geographical directory of the 170 member firms employing tens of thousands of skilled persons in scientific instrument making.

Castrol Pensions Scheme

PENSIONS at twice the present rate are to be given to all male manual employees of the Castrol Group in the United Kingdom who are members, or who later become members, of one of the Group's pension schemes. A skilled workman with thirty years service will get £200 a year for life at 65 instead of £100; a foreman with similar service £300 instead of £150. The new scheme, like its predecessor, is paid for entirely by the Group and workers make no contributions themselves. Several hundred men at the Group's thirteen installations and factories in the United Kingdom are affected. Castrol have also decided that all their employees in the United Kingdom, manual and otherwise, shall participate in the Government's new graduated pension scheme.

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different types of fixing devices for Speed and Strength

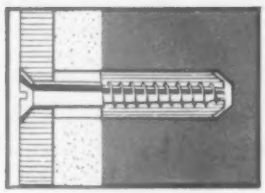
Cut your costs with

RAWLPLUG FIXING DEVICES

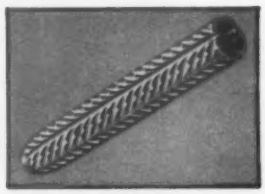
FOR SPEEDY FIXING IN ANY MATERIAL

No more trouble or costly delay because the material was 'difficult'! Whether it's concrete or plastic, breeze or sheet metal, cavity brick or lath and plaster, there's a Rawlplug Fixing Device that makes firm screw or bolt fixings quickly, easily and economically. The speedy answer to every fixing problem is one or other of the 24 different types of Rawlplug Fixing Devices. Write for illustrated brochure.

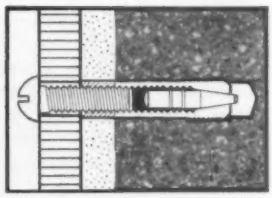
Screw Fixings



Use the famous RAWLPLUG for neat, firm fixings in brick, stone, etc. All sizes up to $\frac{3}{4}$" diameter Coach Screws. Rawlplugs are waterproof and unaffected by climatic conditions.

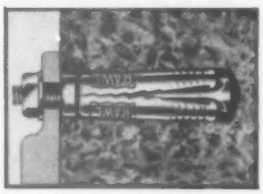


Rawlplug WHITE BRONZE PLUGS are specially suitable when the fixing is subject to very high temperatures, such as the outer brick coverings of furnaces. Use also for under-water fixtures.

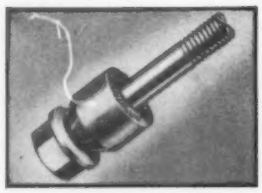


NEW! RAWLSETS, for $\frac{5}{32}$" and $\frac{3}{16}$" Whit. screws, are metal shell sockets which grip by expansion. Ideal for fixing signs, stoves, metal windows, fluorescent light fittings, etc. Write for leaflet.

Bolt Fixings



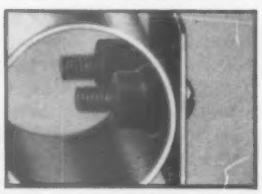
For bolting down machines, use RAWLBOLTS, a *dry* fixing that grips by expansion. No cold chiselling, no waiting for concrete to harden. Sizes up to 1" bolt diameter.



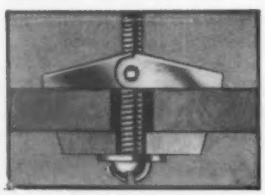
Use Rawlplug BOLT ANCHORS for bolting down in extremely wet or corrosive situations. Caulking completely seals the anchorage. Use also for anchoring Diesel Generators, Power Hammers, etc.

Rawlplug CEMENT-IN-SOCKETS are positioned before concrete is poured, eliminating hole-boring. They provide strong, permanent fixings wherever bolt locations can be pre-determined. For bolt diameters $\frac{1}{4}$" to 1".

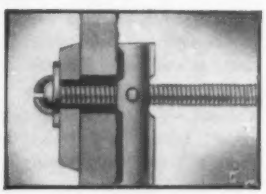
Cavity Fixings



Screwed up from the front the amazing RAWLNUT forms its own rivet head behind the material—airtight, watertight, vibration-proof, squeak-proof! For all thin or hollow materials.



For ceilings of lath and plaster, plasterboard, etc., use Rawlplug SPRING TOGGLES. The inserted Toggle springs open behind the material, spreading the load over a wide area.



Rawlplug GRAVITY TOGGLES are ideal for hollow materials from $\frac{1}{16}$" thick. Inserted horizontally, the long end falls into correct position by gravity. The screw is then tightened in normal way. For $\frac{1}{8}$", $\frac{3}{16}$" and $\frac{1}{4}$" Whit. Screws.

RAWLPLUG

FIXING DEVICES

USED BY THE MILLION THROUGHOUT INDUSTRY

Made by THE RAWLPLUG CO. LTD., CROMWELL ROAD, LONDON, S.W.7

The World's largest Manufacturers of Fixing Devices

B2S9A

Acheson Dispersions

In the 8th edition of "Prospects", the newspaper-format publication of Acheson Colloids Limited, P.O. Box No. 12, Prince Rock, Plymouth, apart from news of applications for Acheson dispersions in various industries, interesting uses at a War Office Proof and Experimental Establishment, the Meteorological Office and Edinburgh University are described. Among the subjects covered are the lubrication of time recorders, telephone switchboard switches, fighting vehicle transmission joints, oven chains, a unique feeding mechanism for polio patients using an Acheson PTFE dispersion, flanging presses and deep drawing/spinning equipment. An unusual use for electrically conducting coatings is featured and an Acheson field engineer explains the function of two "dag" dispersions in an artificial talking machine under development at the Department of Phonetics, University of Edinburgh.

G.E.C. Furnaces

Two new publications describe the standard range of vacuum furnaces made by The General Electric Company Limited, Erith, Kent, in association with Vacuum Industrial Applications Limited and British Geco Engineering Company. Vacuum induction furnaces, dealt with in publication E 46, are suitable for melting and casting metals gas free, from crucibles ranging in capacity from one pound to one ton. The work chamber and oil diffusion pump are mounted on one framework, the rotary pump being mounted separately to avoid vibrating the furnace. Publication E 47 indicates that "cold retort" types of vacuum resistor furnaces are available and are suitable for the laboratory or for production. Sintering, brazing, melting and heat-treatment under vacuum are typical applications for this type of furnace. In addition G.E.C. can also supply special equipments such as vacuum quenching furnaces to meet particular requirements.

Gas Treatment

A leaflet from the Incandescent Heat Company Limited, Smethwick, outlines the products of its gas atmospheres division. These include two types of gas absorber, one using solids, the other liquid scrubbing; acid fume treatment plant; absorption plant; air conditioning plant; air dryers and air preheaters; ammonia dissociators and burners.

Hydraulic Oils

"Hydraulic Oils" is the title of a new 74 page handbook published by Wakefield-Dick Industrial Oils Limited, a member of the Castrol Group of Companies. It contains 50 illustrations and will be useful to engineers concerned with the design, installation, operation or maintenance of hydraulic equipment. Students should find the many graphs and formulae helpful. There are chapters on fundamental hydraulic principles; hydraulic systems, pumps and components; and hydraulic fluids. Copies are available to readers of this journal, free on request to Wakefield-Dick Industrial Oils Limited, Castrol House, Marylebone Road, London NW1.

Molybdenum Disulphide Lubrication

A number of leaflets from Senol Limited, 22 Charlwood Street, London SW1, describe the uses and advantages of molybdenum disulphide lubricants. The material is provided in various forms—dry powder, various grease-like forms, spray, and as additives and in prepared oils. Every kind of duty is catered for from the automotive to the heavy industrial. Molybdenum disulphide improves lubrication under any circumstances and shows to great advantage under conditions of extreme pressure, temperature and speed.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Transistor Components

The transistor has transformed the electronics scene the world over and the market for an increasing range of semi-conductor devices continues to expand rapidly. Many British companies are now engaged in large scale transistor production. To meet the demand for power transistor bases Steel Industries Inc. of Crawfordsville, Indiana, U.S.A., a leading supplier of bases to American manufacturers, has joined with Guest, Keen and Nettlefolds Limited to form Floform Parts Limited a new company aiming to provide in Britain the service available in the U.S.A. A descriptive booklet is obtainable from Floform Parts Limited, Box No. 302, Heath Street, Birmingham 18.

Financing Industry

"Capital for Industry and Trade" is the title of a new leaflet produced by The Charterhouse Group Limited, 30 St. Swithin's Lane, London EC4, which outlines the services provided by member companies. Services thus briefly described include the provision of permanent and semi-permanent capital, sponsoring public issues, offers for sale and placings. Other activities of the group described in the leaflet include merchant banking facilities, hire purchase finance, and insurance of trade credits.

Forging in Magnesium Alloys

A new booklet from High Duty Alloys Limited, Slough, Bucks, gives technical information on three Magnuminium alloys, namely Magnuminium 133, 133X and 266, and on the magnesium-zinc-zirconium alloy ZW3. The data enable an appropriate alloy for particular requirements to be chosen, the physical, mechanical and other properties and heat treatment data being given in each case.

Drum Shot Blasting

The Turbo 60, manufactured by Baker Perkins Limited, is a rotating drum shot blast machine for bulk finishing small parts. The drum is mounted on four rollers on a robust fabricated frame and has a large diameter loading and unloading door. It is equipped with a 4-bladed type turbine with rotor injection and is normally supplied complete with motors and electrical starter gear. Further details are given in a leaflet obtainable from Baker Perkins Limited, Foundry Machinery Department, Bedewell Division, Hebburn-on-Tyne, Co. Durham.

Welding Manipulators

The "Spintil" is a hand-operated, self-balancing manipulator. It gives 360° movement in two planes and enables fabrications (or any other workpiece) to be moved and held in any down-hand position. One of its features is an adjustable slide which allows an adjustable centre of gravity. The "Spintil" is available in three standard sizes and the manufacturers, Yates Plant Limited, Wimborne Street, London WC1. provide a descriptive leaflet.

Machine Gaiters

Plysu Products Limited, who for several years have supplied special gaiters to engineering concerns, have now decided to manufacture a wide range of standard sizes. Known as Corrugaiters they are made from PVC and provide protection for reciprocating shafts and similar telescopic devices against outside contamination. They are available in sizes from ¼ in. to 9 in. internal diameter with a wide choice of end fittings, or to customers' own specifications. Plysu Products Limited, Woburn Sands, Bletchley, Bucks, will send a brochure on request.

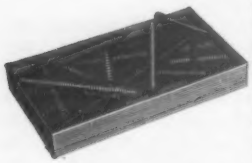
Foundry Mixers

The Baker Perkins range of mixers consists of continuous mullers, delivering up to 300 ton per hr and suitable for either small or large production foundries; continuous mixers, handling large output with low power requirements; a new vertical sand-mixer for the small foundry; and simplex mixers, particularly suited for mixing sand for the CO_2 process. A leaflet describing these is available from Baker Perkins Limited, Foundry Machine Department, Bedewell Division, Hebburn-on-Tyne, Co. Durham.

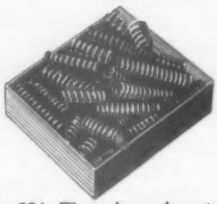
THAT *Experimental Spring* YOU WANT IS WAITING FOR YOU IN THIS BOX...

No. 1217. One gross Assorted Springs. A complete Garage Service Kit. 42/- each.

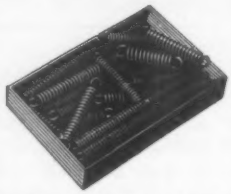
If not, try another box in the Terry Assorted Springs range



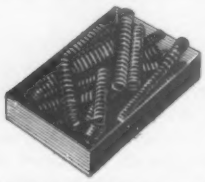
No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**



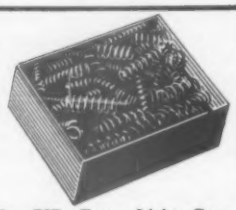
No. 98A. Three dozen Assorted 1" to 4" long, $\frac{1}{2}$" to $\frac{3}{4}$" diam., 19G to 15G. **5/6.**



No. 753. Three dozen Assorted Light Expansion $\frac{1}{2}$" to $\frac{1}{4}$" diam., 2" to 6" long, 22 to 18 S.W.G. **10/6.**



No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long, 22 to 18 S.W.G., $\frac{1}{4}$" to $\frac{1}{2}$" diam. **6/6.**



No. 757. Extra Light Compression, 1 gross Assorted, $\frac{1}{4}$" to $\frac{1}{16}$" diam., $\frac{1}{2}$" to 2$\frac{1}{2}$" long, 27 to 19 S.W.G. **15/-.**

No. 758. Fine Expansion Springs. 1 gross Assorted $\frac{1}{4}$" to $\frac{3}{4}$" diam., $\frac{1}{4}$" to 2" long, 27 to 20 S.W.G. **15/-.**

We know *exactly* how difficult it is to find springs for experimental work . . . we've been making quality springs for over 100 years. So, we confidently offer you our excellent range of small boxed assortments which covers a very wide range.
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HT30

Bishop Auckland. Atcost Limited, Duke Street, Darlington, are to extend their factory on the St. Helen's trading estate.

H. Foster and Sons, builders' merchants, are to erect a tinplate factory at Railway Street. The architects are M. C. Robson and Sons, 245 Newgate Street.

Carlisle. Cowans Sheldon and Company Limited, are to erect new offices to plans by Johnston and Wright, 13 Castle Street.

Chester-le-Street. Kodak Limited, Wealdstone, Middlesex, are to erect distribution depot, and have prepared their own plans.

Darlington. Underground Mining Machinery Limited, Aycliffe Trading Estate, The tender of George Stephenson Limited, Chester Street, Bishop Auckland, has been accepted for extensions of (20,000 sq ft).

Durham. Hugh Mackay and Company Limited, carpet manufacturers. Office additions. The contractors are F. W. Goodyear and Son, 60 Claypath, Durham, and the architects Cordingley and McIntyre, Owengate, Durham City.

Durham County Water Board, Neville Court, are to extend their Honey Hill filtration plant. The cost will be £298,000 and the work will be carried out by direct labour, under the supervision of the Board's Chief Engineer (A. C. Wildsmith).

Greatham (Co. Durham). Cerebos Limited. Factory extensions. The architect is L. Auton, Regent Buildings, York Street, West Hartlepool.

Middlesbrough. Lionweld Limited, Marsh Road, are to proceed with the third phase of their extension scheme, involving the erection of a building 204 ft by 40 ft for the maintenance of vehicles and plant, and a workshop.

Morpeth. J. and J. W. Hall Limited, plant hirers and civil engineering contractors, are to erect new offices at their premises at Clifton Colliery.

Newcastle upon Tyne. Austin Lifts Limited. Factory additions are proposed in Water Street and Penn Street. The architects are A. K. Tasker and Partners, 25 New Bridge Street, Newcastle.

Sunderland. Major and Company are to erect new offices at their oil distribution depot at North Dock.

Wallsend. George Angus and Company Limited. Factory extensions are proposed on the Coast Road. The architects are S. W. Milburn and Partners, 9 Esplanade, Sunderland.

West Hartlepool. The Expanded Metal Company Limited are to carry out considerable extensions to their works for the development of new products for the building industry, and the development of their reinforced concrete interests.

Abergavenny. Coopers Mechanical Joints Limited, Llanfoist Works. The architects for extensions are Thomas & Morgan & Partners, 23 Gelliwasted Road, Pontypridd.

Acton. W. R. Craig & Co. Limited, Palmerston Road, are to erect a new factory in Bollo Lane.

Ashton-under-Lyne. George Nixon & Co. Limited are to extend their Good Hope Mills in Brook Street.

Barnsley. C. G. Carlisle & Co. Limited, Penistone Road, Sheffield, are to erect a cog-rolling and billet-grinding plant.

Barnstaple. Ayers & Grimshaw Limited, 3 Bickington Road. A new factory and office block is to be built.

Bathgate. Telegraph Condenser Company Limited, Whiteside Works. The architects for extensions to the works are D. Peddie McKay & Jamieson, 8 Albyn Place, Edinburgh.

Birmingham. Universal Grinding Wheel Company Limited. Factory extensions.

Blackburn. Park Bros. Limited are to build a new factory on the site of the former wallpaper mill in Gate Street.

Bolton. Tillotsons (Bolton) Limited, Manchester Road. Extensions to works.

The Bleachers Association Limited are to extend their works in Back Bury Lane.

Bootle. Forticrete Limited, Park Lane West. Works extensions.

Bracknell. Premier Precisions Limited, Western Road. The architects for extensions to the works are Foreman & Lockyer, Old Bank Chambers, High Street.

Brighton. Horsell Electrics Limited, 47 Hollingdean Road. New factory.

Bristol. Mardon, Son & Hall Limited. A new factory on Brislington Trading Estate is to be built by Imperial Tobacco Company Limited.

Hardwick Bros. (Bristol) Limited, Newfoundland Road. Extensions are to be made to the factory and offices.

Broadway (Bristol) Engineering Company Limited, Westbury-on-Trym. New factory. Architect, D. Pepperell, 25 Clare Street.

New Factories

Burnley. Prestige Group Limited, 14 Holborn, London EC1, are to make extensions to the factory in Colne Road.

Bury. Walker Chemical Company Limited, Fernhill chemical works, are to make extensions to their works.

Olives Paper Mill Company Limited, Woolfold Mills. New machine shops.

Bury St. Edmunds. Barber-Green Olding & Co. Limited, are to erect a new factory on the Western Industrial Estate.

Camborne. Twentieth Century (Boxes) Limited, The Promenade, Penzance. Plans have been approved for the erection of a new factory in Pool area.

Coventry. H. A. Smith & Sons Limited, Whitefriars Press, Burnsall Road. Factory extensions.

Croydon. S. Warner & Son Limited. Extensions are to be made to the factory in Vulcan Way.

Eckington. J. R. Bramah & Co. Limited, 123 Devonshire Street Sheffield. Works extensions.

Edmonton. Stinehill Furniture Company Limited are to erect a new factory at Angel Factory Colony.

Evesham. Willmott's Limited, Swan Lane, are to build a new factory on land at the junction of Conduit Hill and Rynal Place.

Halifax. John Mackintosh & Sons Limited, are to make extensions to their Albion mills. The architects is A. John Mathewson, 33 Alleyn Park, Dulwich, London SE21.

Harrogate. James Coombes & Co. Limited. The architects for the new factory at Grove Park Terrace are Taylor, Brown & Miller, 8 Victoria Avenue.

Killamarsh. Marrison & Cetherall Limited are to extend their works in Forge Lane.

Liverpool. Sensinwood Limited, Lees Road, Kirkby Industrial Estate are to erect a new factory near Newstet Road.

London. Carnegie Models Limited, 48 Great Portland Street, London W1, are to build a new factory in Osborne Street, E1.

Manchester. Heaton Mills Bleaching Company Limited, Heaton Park Road, Blackley. Extensions are to be made to the works.

Newport. I.O.W. Mews Block Company Limited. Extensions are to be made to the factory in Trevor Road.

Oxford. Hunt & Broadhurst Limited. Land at the rear of Ideal Works, Botley Road, is to be used for extensions to their works.

Peterborough. Delecta Table Waters Limited. Fleur-de-Lys House, Norwich. New factory.

Port Talbot. The Steel Company of Wales are to build a large tonnage oxygen plant at Margam Works.

Portsmouth. Midland Castle Products Limited, propose to erect a new factory at Western Road, Wymering.

Paisley. A. F. Stoddard and Company Limited, carpet manufacturers, have allocated £500,000 for the erection of a new factory at Paisley for the manufacture of tufted carpets.

Rochdale. Mellowhide Products Limited, Molesworth Street, are seeking a site for a new factory.

Shaw. The Oliver Machinery Company Limited are to make extensions to their works.

Sligo. Eire. Biebegs Extracts of Meat Company Limited are to build a new factory at Sligo Quarry.

St. Helens. The Parr factory of Crosby Spring Interiors Limited, Fleet Lane is to be extended.

Sheffield. Seddon & Bramhall Limited, Birley Pit, Woodhouse, are to build light industrial premises at Main Street.

Waterford. Eire. The Munster Chipboard Company, Scariff, Co. Clare, are to erect a new factory at Tycor.

Arbroath. Lincolnshire Canners Limited, of King's Lynn, are to build a new factory near the Metal Box Company new plant at Arbroath.

Cumbernauld. Thames Board Mills Limited, Purfleet, Essex, are to build an 80,000 sq ft factory, employing 200, at Cumbernauld.

Glasgow. Welma Bakeries Limited are to extend their bakery premises at Stamford Street.

Gavin P. MacDonald Limited of 287 London Road, plan to convert premises at 371 Langside Road into a factory for manufacture and printing of jute sacks.

Grangemouth. A West German firm is planning the assembly of cars at Grangemouth. The Town Council is negotiating for a site. The firm has its headquarters in Bremen and would bring in components by sea.

British Enka Limited are to set up a factory at Grangemouth for the manufacture of man-made fibres.

Basildon (Essex). York Shipley Limited. Work has commenced on the first stage of their new factory to be built on a 20-acre site at Basildon, Essex.

Belfast. Bridgeport Brass Company, of Bridgeport, Connecticut, manufacturers of tyre valves, are to start production in Northern Ireland. The Ulster company, to be known as Bridgeport Brass Limited, will occupy a 73,000 sq ft factory at Lisburn, Co. Antrim, built by the Northern Ireland Government.

Hemel Hempstead. Honeywell Controls Limited. A new 30,000 sq ft factory is to be built on the Hemel Hempstead (Herts) Industrial Estate.

Sunderland. Hepworth & Grandage Limited, manufacturers of internal combustion engine components, have acquired a 22-acre site at Southwick, and the first phase of factory construction will begin early in 1961.

CLASSIFIED ADVERTISEMENTS

Machinery, Plant and Accessories For Sale

FOR SALE
NEW ¼" GUILLOTINE—EX STOCK
Motorised Overcrank type. Cutting width 8' 4½". Auto hold-down and all necessary gauges. Depth of gap in open ends 9¼". Weight 17¼ tons. Photo, etc., from
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359, Euston Road, London NW1, or 41, Water Street, Birmingham 3.

"FRIGIDAIRE" Low Temperature Refrigerators. 49 in.w × 28 in.d × 34 in.h ext. Ex Large National User, suitable A.C. or D.C. Deep Freezing, Storage of Ice Cream, Frozen Foods, etc. Price £40.0.0 each. Domestic Refrigerators, Service Cabinets and Cold Rooms also available. A.R.C., 134 Great Portland Street, London W1. MUSeum 4480.

FANS! ! ! for Dust, fume extraction, air conditioning, compressors, accessories, motors, etc.; at considerably reduced prices. People say—"If only we'd known of you before . . . Write for very interesting list. Bellangers, 306 Holloway Road, London N7. North 4117.

Classified advertisements are inserted at the rate of 3/– per line.

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Patents For Sale or License

THE proprietor of British Patent No. 732322, entitled "Jogging Machine" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn St., Chicago 3, Ill. U.S.A.

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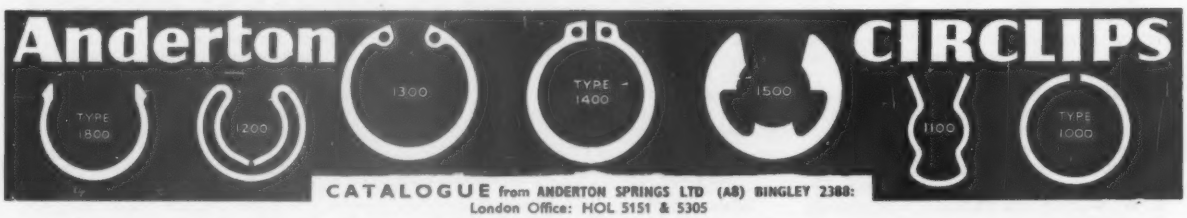

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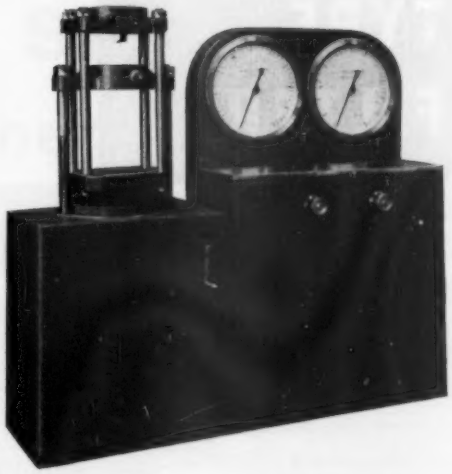

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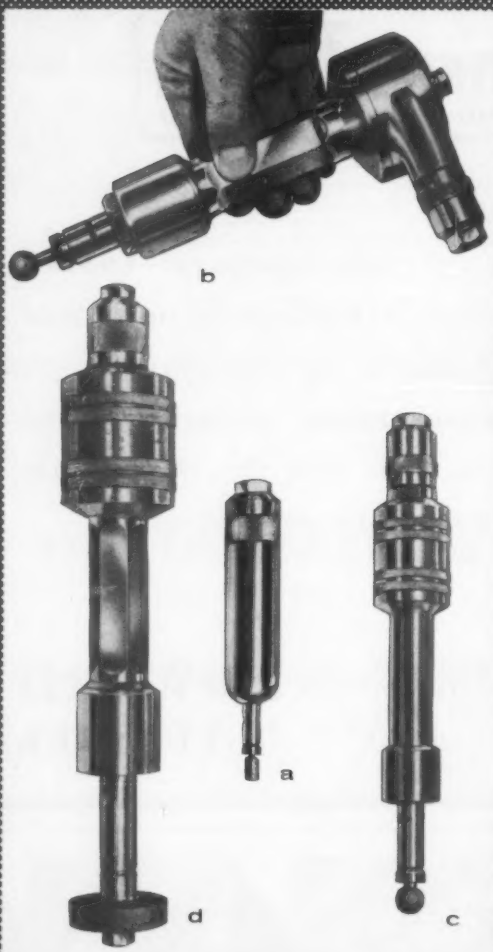

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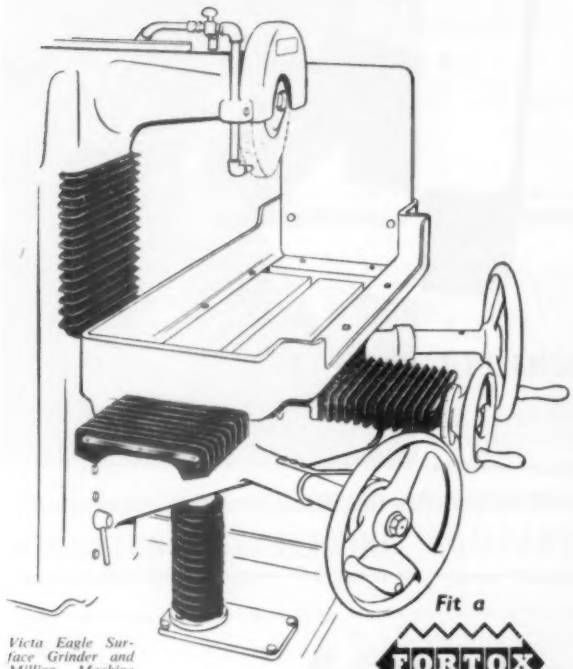

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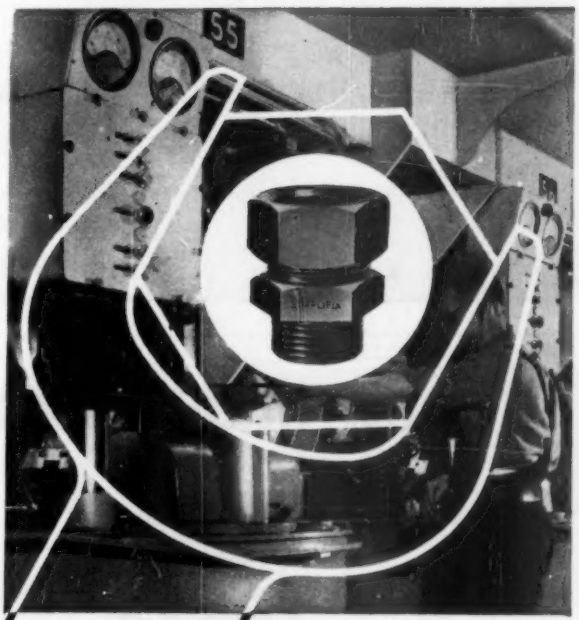

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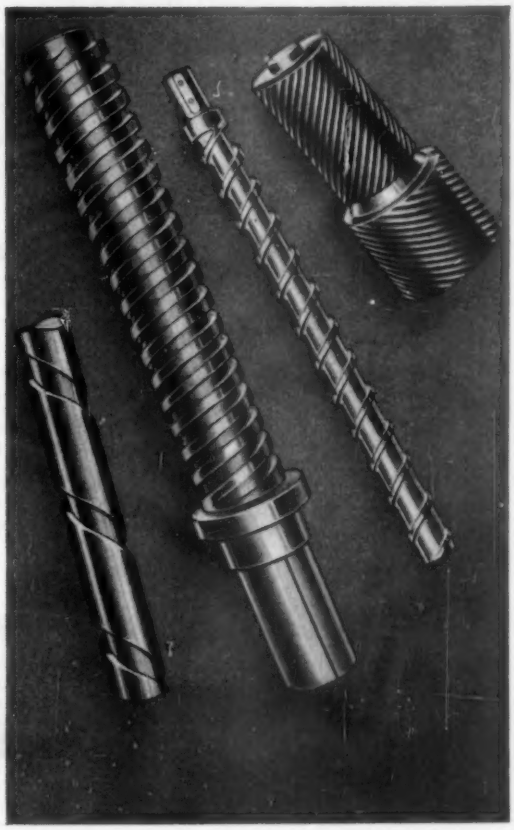

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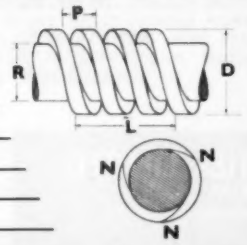

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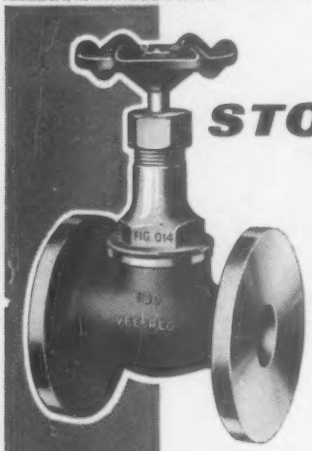

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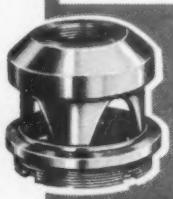

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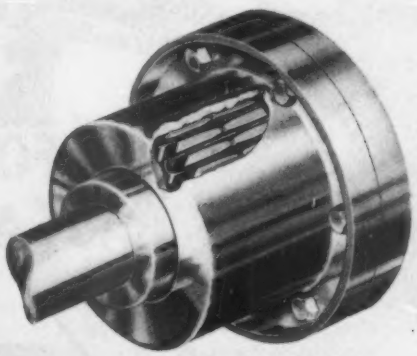

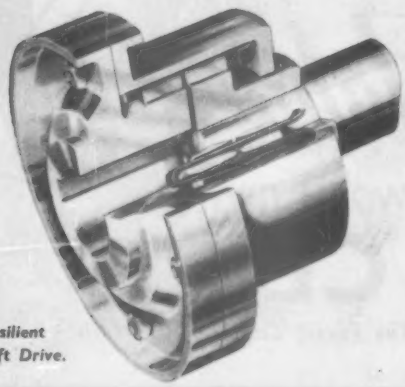

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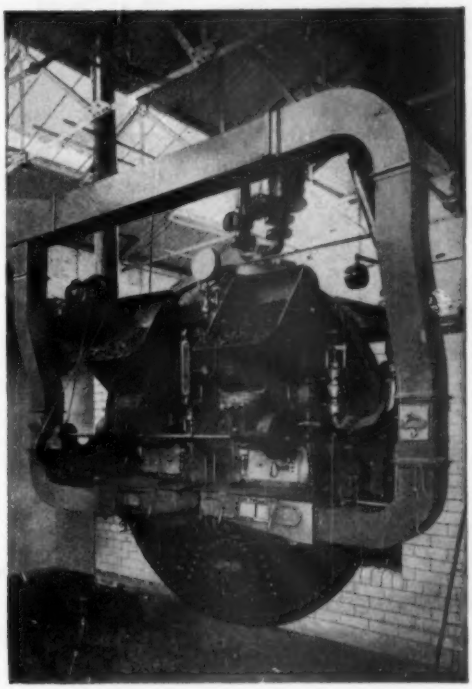

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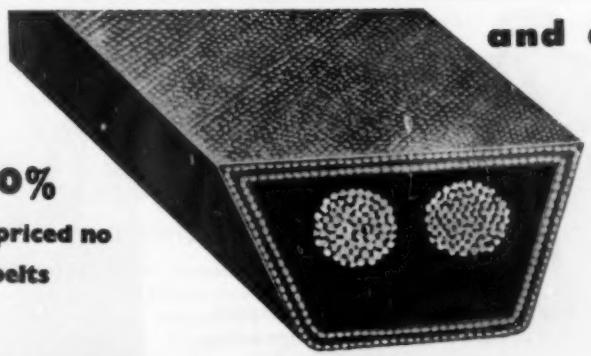

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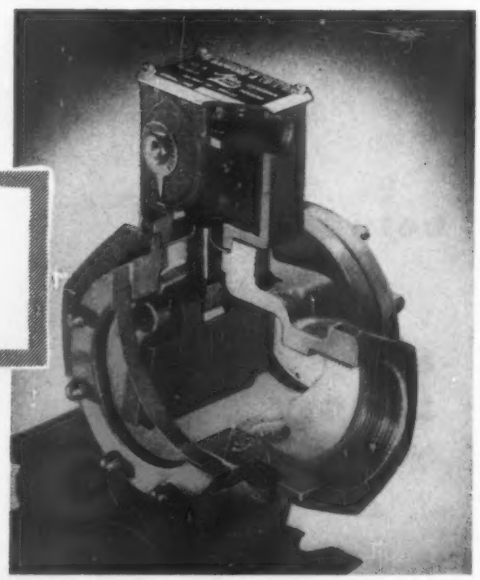

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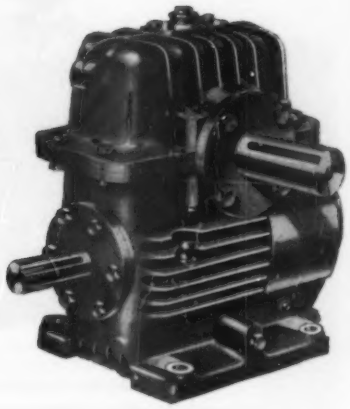

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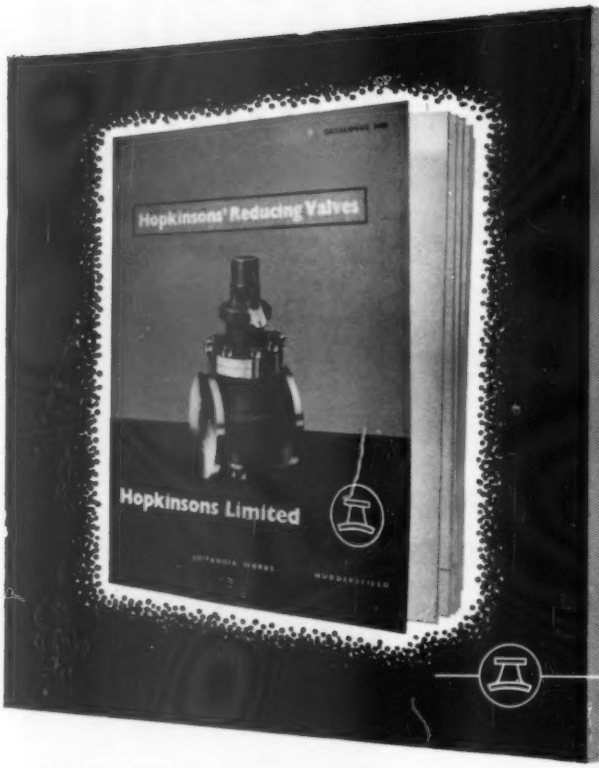

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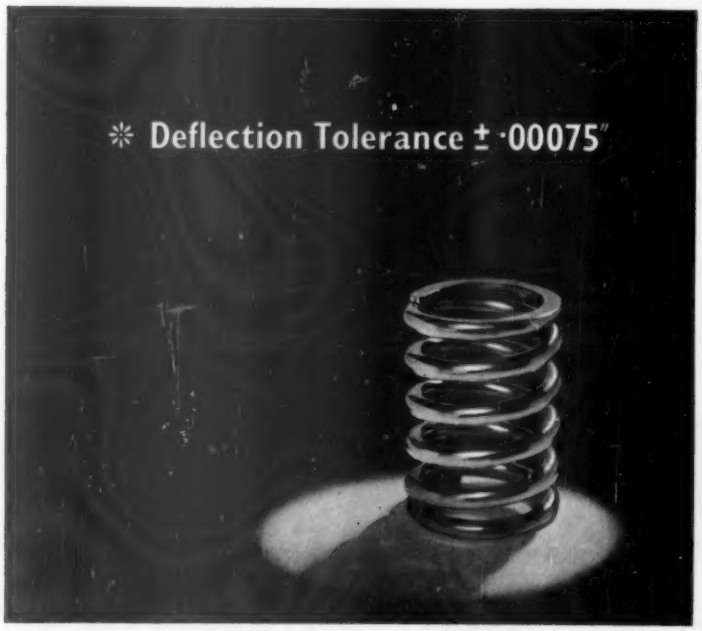

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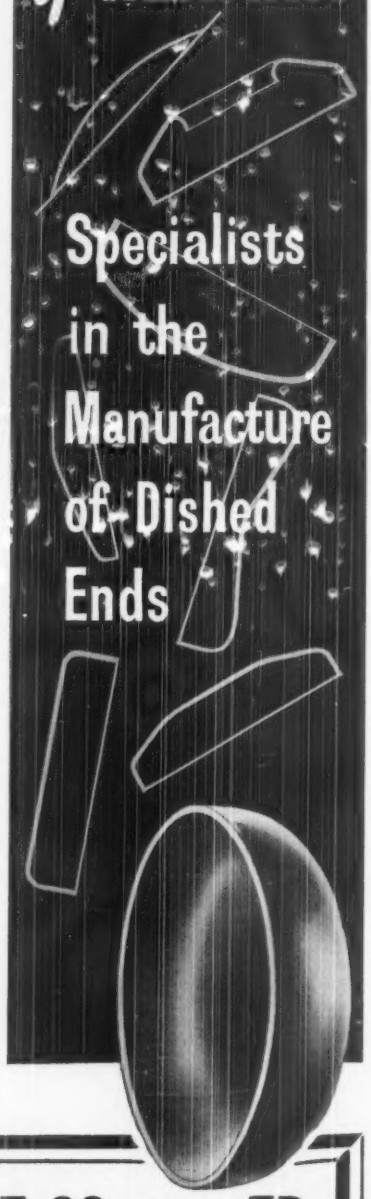

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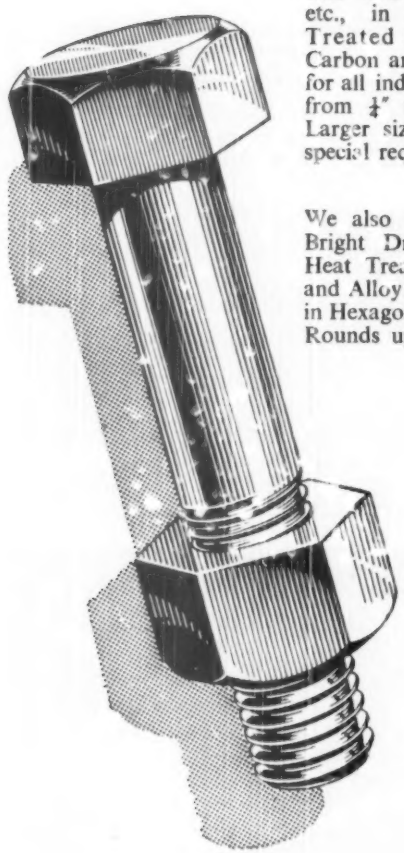

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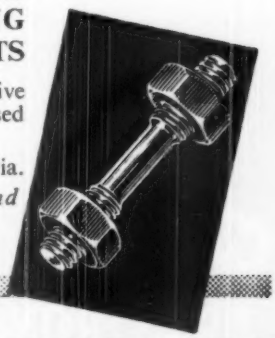

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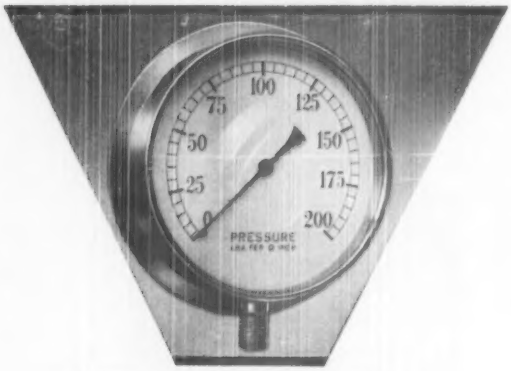

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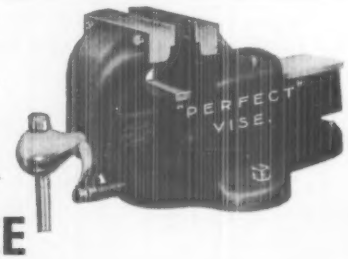

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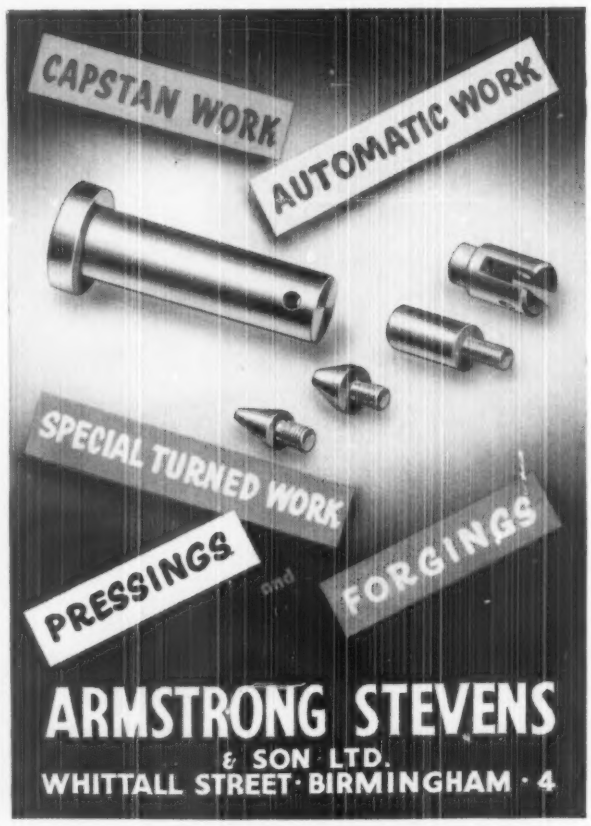

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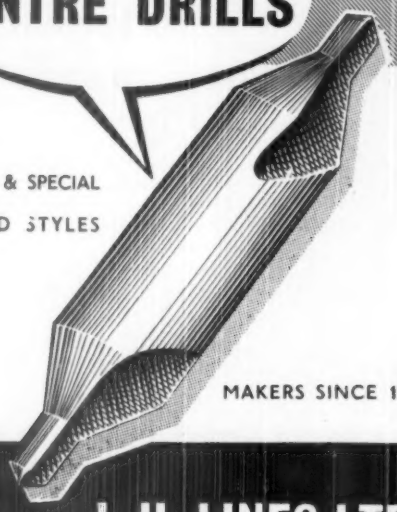

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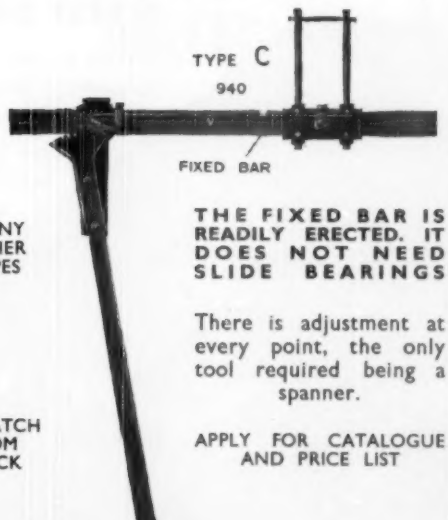

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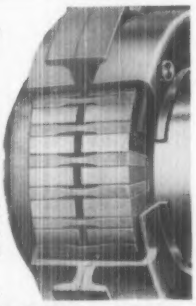

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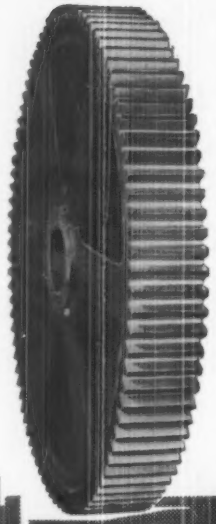

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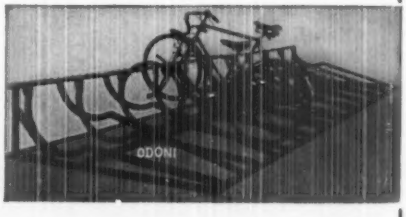

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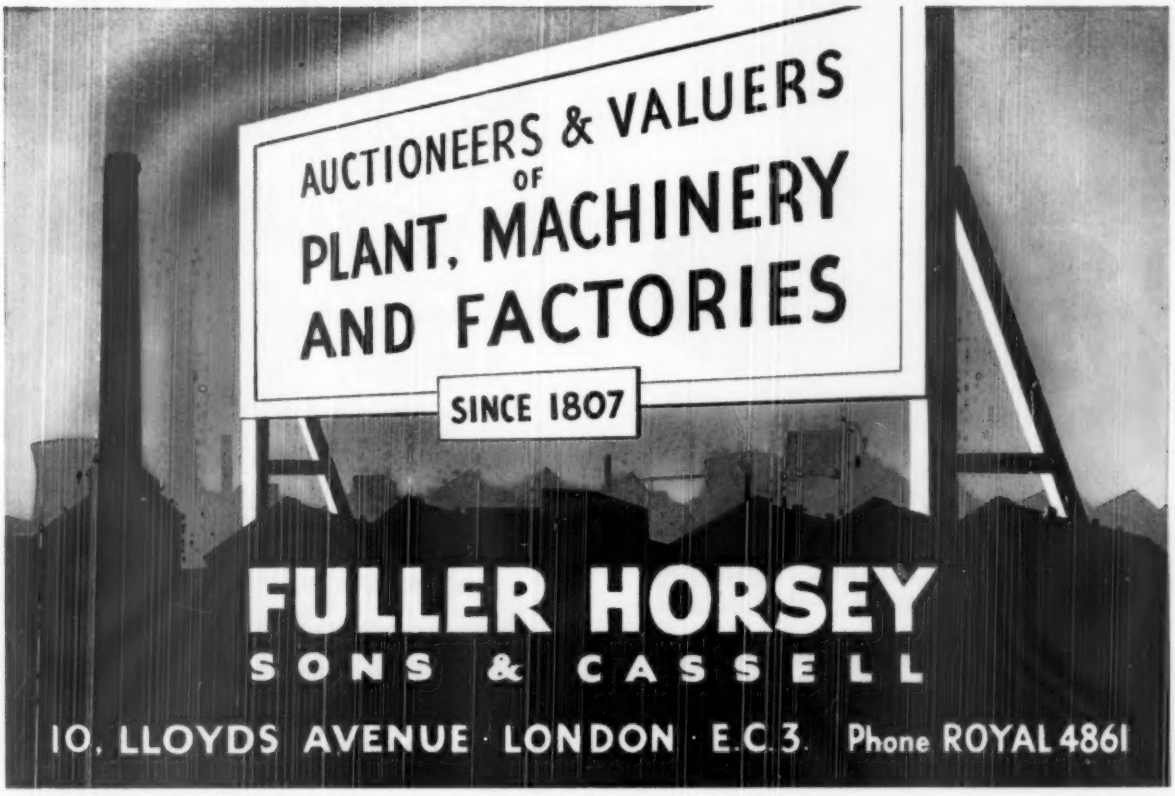

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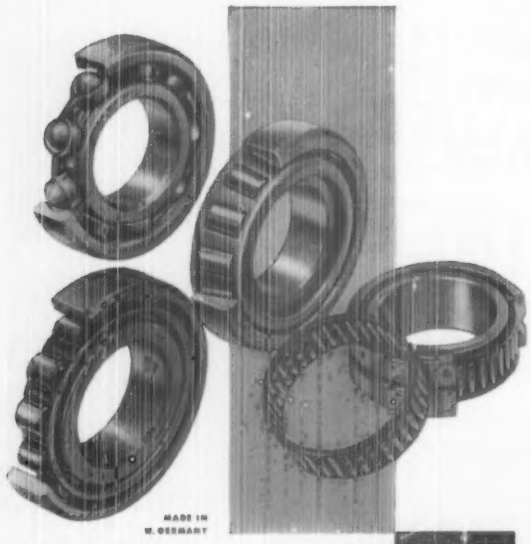

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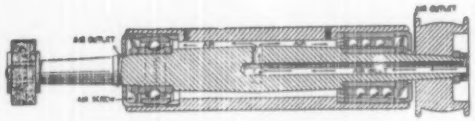

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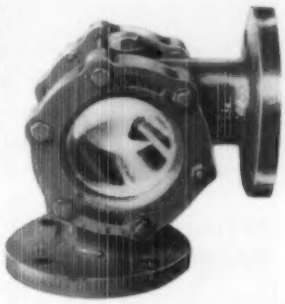

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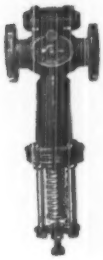

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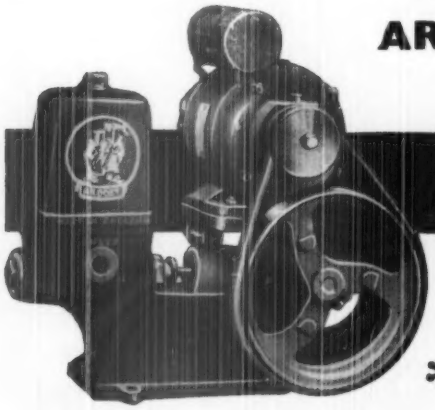

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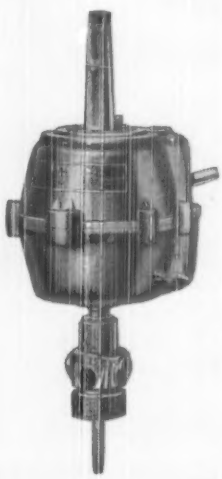

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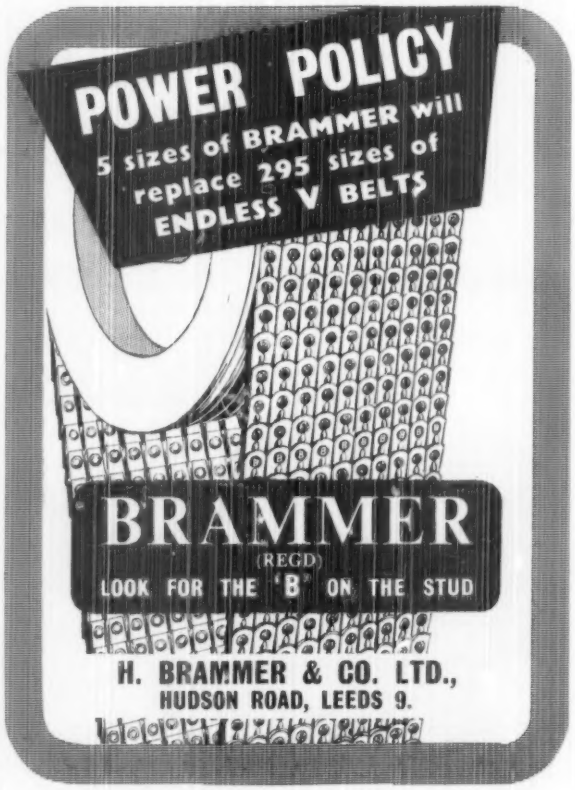

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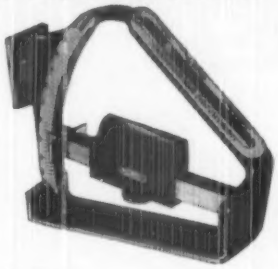

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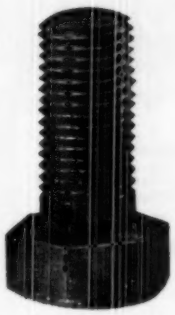

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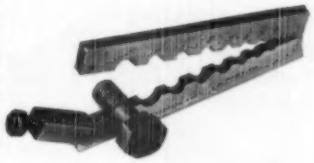

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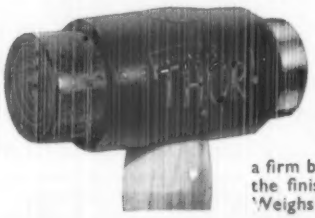

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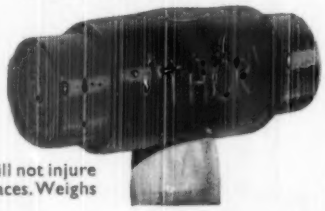

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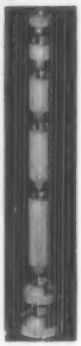

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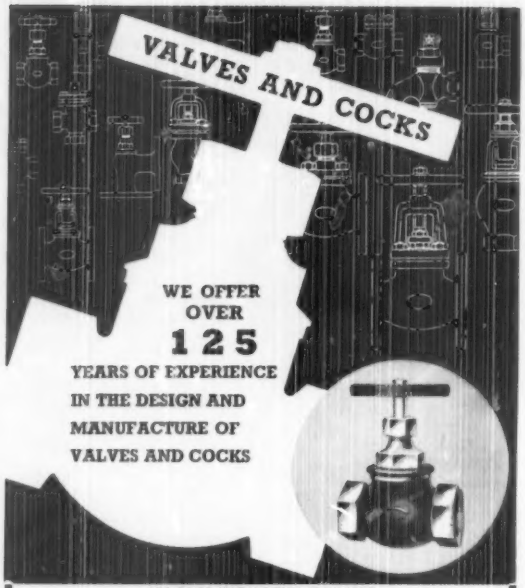

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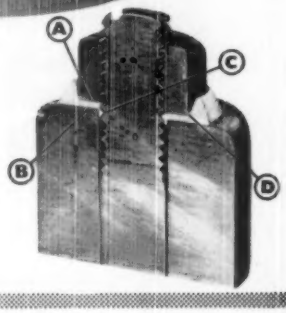

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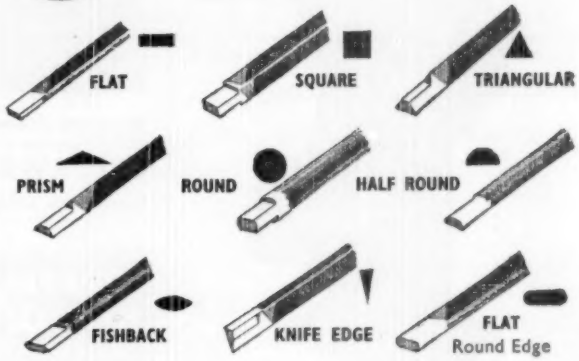

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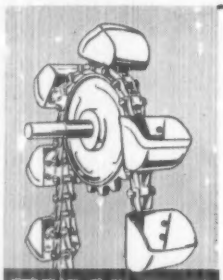

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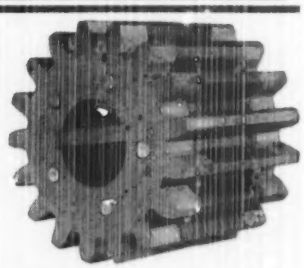

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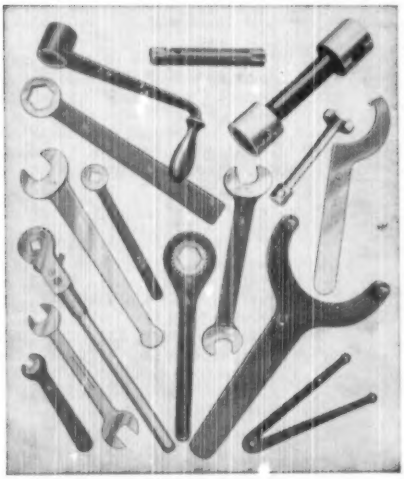

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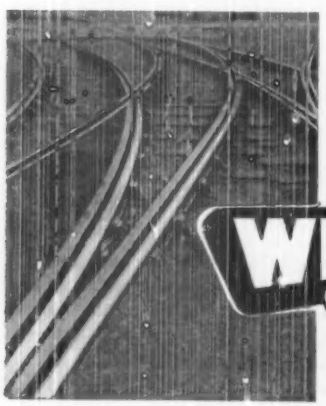

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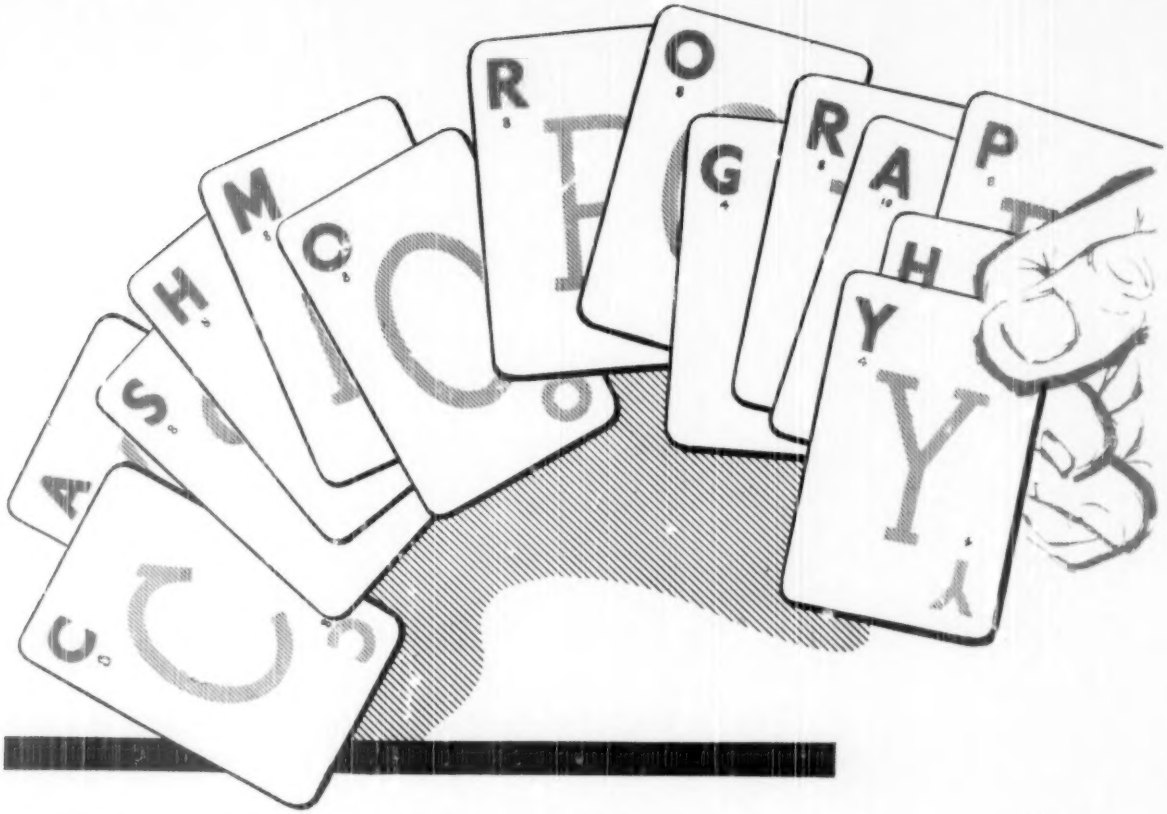

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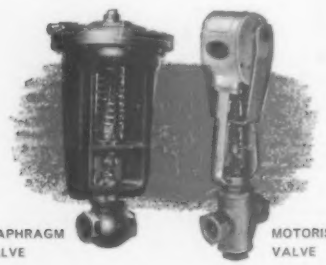

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